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Volume 33, Number 2, January 31, 1976

NUCLEAR SCIENCE ABSTRACTS

A semimonthly publication of the USERDA Office of Public Affairs
Published by the ERDA Technical Information Center

Nuclear Science Abstracts provides the only comprehensive abstracting and indexing coverage of the international nuclear science literature. It covers scientific and technical reports of the U. S. Energy Research and Development Administration and its contractors, other U. S. Government agencies, other governments, universities, and industrial and research organizations. In addition, books, conference proceedings, individual conference papers, patents, and journal literature on a worldwide basis are abstracted and indexed. Each issue of *Nuclear Science Abstracts* includes four indexes: subject, personal author, corporate author, and report number.

The following organizations scan and abstract the nuclear science literature in their respective countries for input to the International Nuclear Information System of the International Atomic Energy Agency. By special agreement, the input to INIS is simultaneously sent to the ERDA Technical Information Center to enhance the timeliness of coverage of that literature in *Nuclear Science Abstracts*.

- Atomic Energy of Canada Limited
- Australian Atomic Energy Commission
- Danish Atomic Energy Commission
- Finnish Atomic Energy Commission
- French Atomic Energy Commission
- Japan Atomic Energy Bureau–Atomic Energy Research Institute
- Commissie Nucleaire Informatieverzorging (Netherlands)
- Institutt for Atomenergi (Norway)
- Aktiebolaget Atomenergi (Sweden)
- United Kingdom Atomic Energy Authority
- Zentralstelle für Atomkernenergie-Dokumentation (West Germany)

Numerous organizations, societies, and publishers throughout the world provide *Nuclear Science Abstracts* with advance page-proof copy of their publications.

A list of the journals scanned regularly and the abbreviations used appears in the January 15 issue of *Nuclear Science Abstracts* and is supplemented in the July 15 issue. The January 15 issue also describes the scope and arrangement of the subject matter covered in *Nuclear Science Abstracts*. The subject matter covered is also described in TID-4552, *Subject Scope of Nuclear Science Abstracts*, available free from the USERDA Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830. An outline of the subject categories appears in the Contents of each issue.

NOTICE

The publication of *Nuclear Science Abstracts* is planned to be discontinued after Vol. 33, No. 12, dated June 30, 1976. *Atomindex*, published by the International Atomic Energy Agency and a product of the International Nuclear Information System (INIS), will provide essentially identical literature coverage, subject scope, abstracting and indexing with that of *NSA*. For all practical purposes the two journals are identical. The Energy Research and Development Administration, formerly the Atomic Energy Commission, has supported the concept and development of INIS for several years. At this time, it is quite apparent that the decentralized scanning, abstracting and indexing on a country-by-country basis is reliable and successful. Consequently, it is no longer necessary for the United States to bear the entire burden of publishing an abstract journal covering the world's nuclear literature. ERDA will continue to provide coverage of U. S. nuclear literature to INIS.

Atomindex is available on a subscription basis from UNIPUB, P. O. Box 433, Murray Hill Station, New York, New York 10016, for $150 per year including cumulative indexes. ($100 per year without cumulative indexes.)

ERDA's new journal, *ERDA Research Abstracts* (*ERA*), will contain abstracts and indexes to all literature of ERDA origin as well as nonnuclear energy information generated by foreign countries with which ERDA has agreements for cooperation. *ERA* is available to government agencies on the same basis as *NSA* and on an exchange basis to universities, research institutions, industrial firms, and publishers of scientific information.

The public may obtain *ERA* from the Superintendent of Documents, U. S. Government Printing Office, Washington, DC 20402. The annual subscription rate for the 12 regular issues including an annual cumulative index is $119 for domestic subscribers, and $148.75 for foreign subscribers. Individual issues will be priced at $7.40 domestic, and $9.25 foreign. Separate annual index cumulations will cost $30.50 domestic, and $38.15 foreign.

INDEXES TO *NSA*

Comprehensive indexes appear in each issue and are cumulated at the end of each volume. The report number indexes will be cumulated on both a volume and two-volume basis. Multivolume cumulations have been issued as indicated above.

All documents abstracted are indexed by subjects and personal authors. Report literature is indexed also by corporate author and report number. Each of these indexes in every issue is preceded by an introduction explaining in detail the organization of the index and the principles by which it is compiled. The reader is referred to these explanations for information not found in the brief summaries below.

Personal Authors

Each author's name is indexed in the form appearing on the document abstracted, with the exception that given names are reduced to initials:

SOLDAN, D.W., Shipping container for a bottle of radioactive material, 32:20442
SOLDAT, J.K., Dosimetry of the radioactive noble gases, 32:19918 (BNWL-SA-4813)
SOLOMAKHA, D.A., Measurement of the 1.15-μm wavelength of a helium--neon laser, 32:19555

Subjects

The subject index consisting of entries naming specific materials, objects, and processes is arranged alphabetically. Document titles, informative phrases, or both specific to these entries are arranged alphabetically under the entries.

Examples:

URANIUM ORES/GEOCHEMISTRY
  Change of uranium concentration in plagioclase of various zones of microcline--albite--oligoclase pegmatites of Karelia, 32:19704
URANIUM ORES/LEACHING
  Preparation of uranium compounds (Patent), 32:19329
URANIUM ORES/MINING
  The uranium mining and its importance for the energy supply, 32:19701
URANIUM ORES/ORE PROCESSING
  Supplies for the fuel cycle for Spanish nuclear power plants, 32:19702
URANIUM OXIDES
  See also URANIUM DIOXIDE
  URANIUM OXIDES U3O8

Corporates

Technical report literature is indexed using the name of the organization or institution responsible for the issuance of the report.

20457 (LA-5954) 100-MHz POWER AMPLIFIER DESIGN AND CONTROL FOR A HEAVY-ION ACCELERATOR. Lunsford, J. S.; Shipley, J. P.; Sutton, J. **(Los Alamos Scientific Lab., N. Mex. (USA)).** Jul 1975. 11p. Dep. NTIS $4.00.

is indexed as:

LOS ALAMOS SCIENTIFIC LAB., N.MEX. (USA)
  100-MHz power amplifier design and control for a heavy-ion accelerator, 32:20457 (LA-5954)
  Characterization of transuranic solid wastes from a plutonium processing facility, 32:19398 (LA-5993-MS)
  Electrical breakdown and tracking characteristics of pulsed high voltages in cryogenic helium and nitrogen, 32:19495 (LA-UR-75-1032)
  Engineering concepts for laser-fusion reactor applications, 32:19493 (LA-UR-75-736)
  Evaluation of pre-impregnated resin-glass systems for insulating superconducting magnets, 32:19583 (LA-UR-75-1099)

Report Numbers

Technical report literature is also indexed using report numbers. This index includes information on where individual reports may be obtained. While not reports, patents and conference papers are indexed here as a matter of convenience.

L-	(Misc.)	
9389	32:20494	See N-74-35219
LA-		
2429	32:20210	Dep. NTIS, $12.00
5931	32:21563	Dep. NTIS, $5.45
LA-tr-		
75-14	32:21506	Dep. NTIS, $7.75
75-26	32:19253	Dep. NTIS, $4.00
LA-UR-		
75-736	32:19493	Dep. NTIS, $4.00
75-791	32:20772	Dep. NTIS, $4.50
75-1331	32:19238	Dep. NTIS, $4.00
LBL-		
2674	32:19889	Dep. NTIS, $9.25
3633	32:21097	Dep. NTIS, $13.50
LFEN-	(Portugal)	
165-b	32:21507	INIS

AVAILABILITY OF PUBLICATIONS ABSTRACTED

Public availability of all U. S. Energy Research and Development Administration reports is indicated in the report number indexes. The availability of other reports, when known, is also indicated. The availability of some unnumbered reports is given in the abstract.

Dissertations from *Dissertation Abstracts International, Part B* that are included in *Nuclear Science Abstracts* are available from Xerox University Microfilms, 300 North Zeeb Road, Ann Arbor, Michigan 48106.

Information on the availability of the published literature and unpublished conference papers abstracted in *Nuclear Science Abstracts* can be obtained from the USERDA Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.

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The Administrator of the Energy Research and Development Administration has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this agency. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through June 30, 1978.

Volume 33, Number 2 January 31, 1976

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical and Separations Chemistry

Refer also to abstracts 3410 and 4288.

Activation and Nuclear Reaction Procedures

Refer also to abstracts 3102, 3498, and 4524.

2557 (DP-MS-75-37) 100 mg ^{251}Cf ACTIVATION ANALYSIS FACILITY AT THE SAVANNAH RIVER LABORATORY. MacMurdo, K. W.; Bowman, W. W. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. (USA). Savannah River Lab.). 1975. Contract AT(07-2)-1. 26p. (CONF-751009-2). Dep. NTIS $4.50.

From international nuclear and atomic activation analysis conference; Gatlinburg, Tennessee, USA (14 Oct 1975).

The ^{252}Cf Activation Analysis Facility at the Savannah River Laboratory (SRL) is used routinely for multielement analyses of a wide variety of solid and liquid samples (e.g., metal alloys, fly ash and other airborne particles, rocks, and aqueous and nonaqueous solutions). An automated absolute activation analysis technique, developed to use neutron transport codes to calculate multienergy group neutron spectra and fluxes, converts counting data directly into elemental concentrations expressed in parts per million. The facility contains four sources of ^{252}Cf totaling slightly over 100 mg. A pneumatic "rabbit" system permits automatic irradiation/decay/counting regimes to be performed unattended on up to 100 samples. Detection sensitivities of less than or equal to 400 ppb natural uranium and less than or equal to 0.5 nCi/g for ^{239}Pu are observed. Detection limits for over 65 elements have been determined. Over 40 elements are detectable at the one part per million level or less. Overall accuracies of +- 10 percent are observed for most elements. (auth)

2558 (DP-MS-75-38) DATA REDUCTION IN THE 100 mg ^{252}Cf ACTIVATION ANALYSIS FACILITY AT THE SAVANNAH RIVER LABORATORY. Bowman, W. W.; MacMurdo, K. W. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. (USA). Savannah River Lab.). 1975. Contract AT(07-2)-1. 15p. (CONF-751009-3). Dep. NTIS $4.50.

From international nuclear and atomic activation analysis conference; Gatlinburg, Tennessee, USA (14 Oct 1975).

The automated absolute activation analysis technique developed at the Savannah River Laboratory is based on the ability to predict neutron capture reaction rates from tabulated cross sections and neutron spectra accurately calculated for the 100-mg ^{252}Cf source. A series of computer programs comprises the data reduction system which: (1) reduces the gamma-ray spectra to lists of photopeak energies, areas, and statistical errors for all significant photopeaks, (2) assigns each gamma ray to the appropriate activation product by comparing experimental to tabulated gamma-ray energy, (3) converts each photopeak area into an elemental concentration using the experimental timing data, calculated reaction rates, detector efficiency, and activation product spectroscopic data in the absolute activation master equation. The data reduction system requires about one second of IBM 360-195 CPU time for the conversion of each 4096 channel spectrum into a qualitative and quantitative list of elemental composition. The accuracy of the algorithm is better than +- 15 percent for most elements. (auth)

2559 (LBL-4000, pp 353-357) ALASIYA OF THE AMARNA LETTERS. Artzy, M. (Hebrew Univ., Jerusalem); Asaro, F.; Perlman, I. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

2560 (LBL-4000, pp 362-364) EVIDENCE IN SUPPORT OF SIMILAR SOURCE MATERIAL IN THE GENESIS OF ALKALIC BASALTS. Bowman, H. R. (Univ. of California, Berkeley); Asaro, F.; Carmichael, I. S. E.; Mark, R. K.; Schmincke, H. U. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

2561 (LBL-4000, pp 364-366) OCEAN RIDGE-LIKE THOLEIITES IN THE NORTHERN GREAT BASIN OF NEVADA. Bowman, H. R. (Univ. of California, Los Angeles); Asaro, F.; Mark, R. K.; Hu, C. L.; McKee, E. H.; Coats, R. R. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

2562 (LBL-4000, pp 366-367) RARE EARTH AND TRACE ELEMENT PATTERNS IN HISTORIC AZOREAN LAVAS. Bowman, H. R. (Ruhr Univ. Bochum, Ger.); Flowers, M. F. J.; Schmincke, H. U. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

2563 (NP-20568) ANALYSIS OF GAMMA SPECTRA PHOTOPEAKS BY THE LEAST-SQUARES METHOD USING A DATA PROCESSING SYSTEM. Pedrajo, A. B. B. (Instituto Politecnico Nacional, Mexico City. Escuela Superior de Ingenieria Mecanica y Electrica). 1973. 106p. (In Spanish). Dep. NTIS (US Sales Only) $8.25.

Thesis.

A program is written which permits an analysis of the γ spectra of a mixture of radioisotopes in agreement with a library of the spectra of the elements forming the mixture. The program will make an adjustment as a combination of standards by the least-squares method, analyze the spectrum obtained by comparison with the original, and apply to the residues obtained the criteria of means, variance, standard deviation, χ square, its relation quotient, and the correlation coefficient. The program is written in Fortran. (JSR)

2564 (RCN-233) BROMINE CONTENT OF SOME DUTCH CROPS AND FRUITS. Admiraal, P.; Kik, H. A.; Das, H. A.; Hoede, D.; Zonderhuis, J. (Stichting Reactor Centrum Nederland, Petten). Sep 1975. 21p. Dep. NTIS (US Sales Only) $4.50.

The natural bromine-content of Dutch potatoes, vegetables and fruits was determined by instrumental neutron activation analysis. Results are given for 348 samples divided over 20 crops and fruits. The data are compared to values published in literature. (auth)

2565 NEUTRON ACTIVATION ANALYSIS. Lukens, H. R.; Schlesinger, H. L.; Bryan, D. pp 45-71 of Systematic Materials Analysis. Vol. II. Richardson, J. H. (ed.). New York; Academic Press (1974).

In the qualitative and quantitative determination of chemical elements neutrons are used to generate indicator isotopes which are measured by the emitted radiation. The area under the gamma photopeak is proportional to the specific activity of the induced radiation and hence to the amount of the element in the sample. Programs are available to produce plots of the spectra, or to scan a spectrum, locate the peaks, determine their energy and assign possible identification based on a program stored table of isotope energies (included in the book in sequence of energy from 50-1122 keV). The precision is greater than 0.2 percent. There is no theoretical reason why the accuracy should not be equal to the precision because only the addition of radioactive contaminant can affect the accuracy of the result. (Metals Abstr.)

2566 DEVELOPMENT OF PROTON-INDUCED X-RAY EMISSION TECHNIQUES WITH APPLICATION TO MULTIELEMENT ANALYSES OF HUMAN AUTOPSY TISSUES AND OBSIDIAN ARTIFACTS. Nielson, K. K. Provo, UT; Brigham Young Univ. (1975). 164p. University Microfilms Order No. 75-15,952. Thesis (Ph. D.).

A method of trace element analysis using proton-induced x-ray emission (PIXE) techniques with energy dispersive x-ray detection methods is described. Data were processed using the computer program ANALEX. PIXE analysis methods were applied to the analysis of liver, spleen, aorta, kidney medulla, kidney cortex, abdominal fat, pancreas, and hair from autopsies of Pima Indians. Tissues were freeze dried and low temperature ashed before analysis. Concentrations were tabulated for K, Ca, Ti, Mn, Fe, Co, Ni, Cu, Zn, Pb, Se, Br, Rb, Sr, Cd, and Cs and examined for significant differences related to diabetes. Concentrations of Ca and Sr in aorta, Fe and Rb in spleen and Mn in liver had different patterns in diabetics than in nondiabetics. High Cs concentrations were also observed in the kidneys of two subjects who died of renal disorders. Analyses by atomic absorption and PIXE methods were compared. PIXE methods were also applied to elemental analysis of obsidian artifacts from Campeche, Mexico. Based on K, Ba, Mn, Fe, Rb, Sr and Zr concentrations, the artifacts were related to several Guatemalan sources. (Diss. Abstr. Int., B)

2567 NON-DESTRUCTIVE PLANT-NUTRIENT ANALYSIS BY NEUTRON ACTIVATION AND X-RAY FLUORESCENCE TECHNIQUES. Das, S. K.; Upadhyay, S. R.; Banerji, K. C. (Fertilizer Corp. of India Ltd., Sindri). Technology (Sindri); 11: No. 2-3, 209-213(1974).

Neutron activation analyses were made on two soil samples and x-ray fluorescence analysis was made on one. The decay spectra obtained from the activation analysis showed the presence of ^{27}Mg, ^{56}Mn, and ^{28}Al in one sample and of ^{56}Mn and ^{24}Na in the other. Quantitative evaluations are being made of the Mg in one sample and of Na and Mn in the other. The x-ray fluorescence analysis showed the presence of Fe and the quantitative evaluation of this and other elements is in progress. (JSR)

2568 USE OF NO_3-FORM ANION EXCHANGE RESIN FOR NEUTRON ACTIVATION ANALYSIS OF GOLD IN ZINC. Hirose, A.; Ishii, D. (Nagoya Univ. (Japan). Faculty of Engineering). Nippon Kagaku Kaishi; 1974: No. 12, 2351-2355(Dec 1974). (In Japanese)

A method was developed for the determination of traces of gold in pure zinc by neutron activation analysis using ion exchange preconcentration. Five grams of sample were transferred to a 50-ml beaker and dissolved in a lease amount (about 30 ml) of 9:1 mixture of HNO_3 and HCl. The sample solution was slowly cooled to room temperature on standing, diluted to 50 ml with water, and passed through a small column packed with 150 mg (wet basis) of Dowex 1-X8 AG anion exchange resin (Cl-form, 100 ~ 200 mesh) to separate gold from zinc. Resin samples together with standards were irradiated with pneumatic tube system of JRR-2 reactor at a flux of 7×10^{13} n/cm^2/sec for 20 minutes. After being cooled for about 5 hours to allow ^{38}Cl to decay out, the irradiated resin was slurried with water and transferred into a column previously packed with 50 ~ 100 mg of non-irradiated Dowex 1-X8 resin (Cl-form, 100 ~ 200 mesh), then treated with 20 ml of 0.5 N HCl solution to elute out the interfering nuclides. ^{198}Au remained on resin was then counted with a Ge(Li) detector after cooling for about 7 hours, or with a NaI(Tl) detector after cooling for about 1 day. The chemical yield of gold was about 98%, and the concentration factor was 2.2×10^7. The blank was 0.05 ng on an average. The minimum determinable and detectable masses are thus presumed to be about 0.5 ng (10-fold of blank) and 0.1 ng (2-fold of blank), respectively. (auth)

2569 NONDESTRUCTIVE ACTIVATION ANALYSIS OF Br IN KCl SINGLE CRYSTALS. Yamadera, A.; Miyata, T.; Shiokawa, T. (Tohoku Univ., Sendai (Japan). Faculty of Science); Maki, M. Kakuriken Kenkyu Hokoku; 7: No. 1, 201-203(Jun 1974). (In Japanese)

Single crystals of KCl and standard samples of KCl containing known amount of KBr were sealed in quartz ampoules, and irradiated with photons. After the irradiation, the intensity of 2.10-MeV γ ray emitted from ^{34m}Cl formed by $^{35}Cl(\gamma,n)^{34m}Cl$ reaction was determined. After the decay of ^{34m}Cl, the intensity of 37-keV γ ray emitted from ^{80m}Br formed by $^{81}Br(\gamma,n)^{80m}Br$ reaction was measured. The ^{34m}Cl was used as a monitor to correct the intensity of the bremsstrahlung irradiated on each sample. The calibration curve for the standard samples was linear, and its gradient was 1. Therefore, the area of the photoelectric peak of ^{80m}Br is proportional to the amount of Br. The results of quantitative analysis were satisfactory for the content between 0.4×10^0 to 1.3×10^3 ppM. The limit of determination was 1 ppM, though the limit was expected to be 0.2 ppM Br in 50 mg KCl. The rise of background due to the presence of minute amount of impurities is possibly the cause of this discrepancy. The peak of ^{80m}Br at 37 keV was mainly used for the determination. Fluorescent x-rays of In, which was present in the samples as an impurity, did not interfere with the determination. (JA)

2570 ACTIVATION ANALYSIS OF IMPURITIES IN ARTIFICIAL MINERALS. Takei, F.; Kobayashi, T. (Tohoku Univ., Sendai (Japan). Research Inst. for Iron, Steel, and Other Metals). Kakurinken Kenkyu Hokoku; 7: No. 1, 219-223(Jun 1974). (In Japanese)

Activation analysis was applied to the determination of carbon in silicon semiconductors. The silicon single crystals grown by Czochralski method were irradiated with bremsstrahlung of maximum energy of 30 and 60 MeV for 20–40 minutes. Gamma-ray peak measurement was made 1 hour, 24 hours, and 1 month after the irradiation. The formation of ^{11}C, ^{29}Al, ^{28}Al, ^{22}Na, ^{28}Mg, and ^{24}Na was confirmed by the position of the peaks. Samples of carbon, carborundum and polyethylene film were used as standards. After the irradiation, ^{28}Al, ^{29}Al, and ^{11}C were noticed for carborundum. After the irradiation of polyethylene, no peak other than 0.51 MeV, which corresponded to C, was found. The carbon content was calculated by the equation: $W = AW'/A'$, where W and W' are the carbon content in silicon and in a standard sample, respectively, and A and A' are the radioactive intensity of ^{11}C formed by the irradiation of silicon and the standard sample, respectively. The results of determination of carbon content in 3 different kinds of silicon were 0.80, 0.80, and 1.86 μg, respectively. For accurate determination, larger amount of samples and the increase of electric current were preferable for the bremsstrahlung of 30 MeV. Although 60-MeV irradiation is accompanied by various shortcomings, the sensitivity of determination is expected to be larger by 60-MeV than by 30-MeV irradiation. (JA)

2571 EFFECTIVE SCHEME FOR INSTRUMENTAL ACTIVATION ANALYSIS OF THE EYE TISSUE. Kryzhenkova, N. A.; Zhuk, L. I.; Kist, A. A. Vestn. Oftal'mol.; 2: 57-59(1972). (In Russian).

The scheme enables differential analysis of the human eye tissues to be realized for 13 elements in batches weighing a few mg. The neutron-activation method reposes on irradiation of specimens with a stream of neutrons with subsequent identification of the resultant radioisotopes. The elaborated scheme incorporates a successive determination of oxygen with reference to the radioisotope ^{16}O, of nitrogen with the radioisotope ^{13}N, vanadium and aluminum with the radioisotopes ^{52}V and ^{28}Al, chlorine with the radioisotope ^{38}Cl, sodium with the radioisotope ^{24}Na, sulphur and phosphorus with the radioisotope ^{32}P, potassium with the radioisotope ^{42}K, iodine with the radioisotope ^{128}I, bromine with the radioisotope ^{82}Br, iron and zinc with the radioisotopes ^{56}Fe and ^{64}Zn. The proposed scheme permits a differential multielement analysis of the eye tissues to be made with sufficient accuracy and high efficiency. It was used in serial analyses of normal human eye tissues and those of the dog (retina and choroid, crystalline lens, sclera, cornea, vitreous body, and chamber fluid), as well as of the human crystalline lens in cataractous eyes. A table listing the content of 11 elements in the lucid human crystalline lens is attached. (auth)

2572 CONCENTRATION OF COPPER AND ZINC IN PIGMENTED, DEMAL NEVI. Carlson, G. O.; Anneroth, G. (Karolinska Institutet, Stockholm). Sv. Tandlakareforb. Tidn.; 65: No. 5, 269-277(May 1972).

Values are reported for the trace metals copper and zinc in human dermal nevi as calculated by activation analysis. The mean value for copper was 6.5 ± 2.6 ppm. Only one of sixteen samples contained zinc in measurable quantity (85 ppm). All values were calculated on dry weight. The tissue samples have also been studied by conventional histological staining methods and microradiography. The relative distribution of the dry weight has been studied on the microradiographs and the thickness of the external horny layer calculated. (auth)

2573 COMPARISON OF METHODS OF DETERMINATION OF IMPURITIES IN BORON. Thevebot, F.; Viala, J. C. Analusis; 3: No. 2, 76-83(Feb 1975). (In French).

Spark mass spectrometry allows the localized analysis of all the elements to be carried out by direct sparking and without using standards. The dry corrosion of solid B in air at up to 105°C may be studied with this method. Activation by means of 54-MeV α-particles may be used for the non-destructive determination of O. The isotope ^{18}F with a half-life of 2h is obtained, and the sensitivity is 1-10 ppm for high-purity B. Atomic-absorption methods may be used for the determination of various metals and Si. The sensitivities of the various techniques are compared. (Metals Abstr.)

2574 DETERMINATION OF MANGANESE IN SEMICONDUCTOR-GRADE SILICON BY A NEUTRON-ACTIVATION METHOD. Zmijewska, W. Chem. Anal. (Warsaw); 19: No. 4, 861-867(1974). (In Polish).

A method of measuring the acitivity of ^{56}Mn for the determination of Mn in semiconductor-grade Si samples was developed. The samples (0.2 – 0.5g), together with standards, were irradiated in a nuclear reactor for 10 min to 2 h. Mn was separated from the Si matrix by extraction with excess sodium diethyldithiocarbamate followed by extraction with a substoichiometric amount of teraphenylarsonium chloride. The Si was separated as SiO_2. The lower limit of determination was Mn 1 ng. The stan ard deviation was 10.7% for Mn 5 ng. (Metals Abstr.)

Chemical and Spectral Procedures

Refer also to abstracts 3012 and 3098.

2575 (DP-1384) EQUILIBRIUM DISTRIBUTION OF URANYL NITRATE BETWEEN NITRIC ACID AND 7.5 VOL PERCENT TBP. Thompson, M. C.; Murphree, B. E.; Shankle, R. L. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. (USA). Savannah River Lab.). Oct 1975. Contract AT(07-2)-1. 22p. Dep. NTIS $4.00.

The distribution of nitric acid and uranyl nitrate between aqueous solution and 7.5 vol percent tributyl phosphate in normal paraffin diluent was measured at 23, 45, and 60°C. The data are consistent with behavior expected from theory and with previously published data. The data have been used to design a solvent extraction flowsheet for recovery of enriched uranium. (auth)

2576 (LA-6010) ALLCAL: AN INTERACTIVE BASIC PROGRAM FOR SPECTROCHEMICAL CALCULATIONS. Apel, C. T. (Los Alamos Scientific Lab., N. Mex. (USA)). Jun 1975. Contract W-7405-eng-36. 18p. Dep. NTIS $4.00.

An interactive program, ALLCAL, has been developed at Los Alamos Scientific Laboratory (LASL) to calculate the results of spectrochemical measurements of impurities in production samples. The program generates a working curve from input data of standard samples to calculate the impurity concentrations. ALLCAL permits use by individuals with minimal programming experience; it is truly interactive in providing periodic means to edit, modify, and change incorrect data that might have been introduced through various human error factors affecting any computer program, without the need to terminate and reinitialize after such editing. The program can be used as a research tool to manipulate data with minimum effort and eliminates repetitive input data from its operation. It also provides the spectroscopist a comparison mode to evaluate the effect of the use or nonuse of a given internal standard. ALLCAL accepts either optical density or percent transmittance data from photographic plates and films. The program is written in BASIC language for a minicomputer with 28,000 octal words of core memory and has been shown to be adaptable to another computer system with slight modifications. (auth)

2577 (SAND-75-5472) QUALITATIVE DEPTH PROFILE ANALYSIS OF METAL HYDRIDE FILMS USING AN ION MICROPROBE MASS ANALYZER. Perkins, W. G.; Foesch, J. A. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1975. 10p. (CONF-750863-1). Dep. NTIS $4.00.

From 10th annual conference on microbeam analysis; Las Vegas, Nevada, USA (11 Aug 1975).

Current data acquisition and reduction techniques are described, some of recent depth profiling results are reported, and possibilities of semiquantitative analysis for hydrides are speculated on. (LK)

2578 ATOMIC ABSORPTION DETERMINATION OF ULTRATRACE TELLURIUM IN ROCKS UTILIZING HIGH SENSITIVITY SAMPLING SYSTEMS. Beaty, R. D. Rolla, MO; Univ. of Missouri (1973). 70p. University Microfilms Order No. 75-15,811. Thesis (Ph. D.).

The sampling boat and the graphite furnace were shown to possess the required sensitivity to detect tellurium at ultratrace levels, in a variety of sample types, by atomic absorption. In the sampling boat approach, tellurium in sample solutions is chemically separated and concentrated by extraction into methyl isobutyl ketone before measurement. For samples exhibiting extraction interferences or excessively high background absorption, a preliminary separation of tellurium by coprecipitation with selenium is described. Using this technique, tellurium can be quantitatively detected down to 5 nanograms and linear response is observed to 100 nanograms. Relative standard deviations of better than 7 percent are achieved for 50 nanograms of tellurium. For samples that have a tellurium content below the detection limits of the sampling boat, the graphite furnace is used for atomization. By this method, as little as 0.07 nanograms of tellurium can be detected, and a precision of 1 percent relative standard deviation is achievable at the 5 nanogram level. A routinely applicable procedure was developed for determining tellurium in rocks, using the graphite furnace, after a hydrofluoric acid decomposition of the sample. Using this procedure, tellurium data were obtained on 20 different rocks, and the significance of this new information is discussed. (Diss. Abstr. Int., B)

2579 STUDY OF THE URANYL PERIODATE COMPLEXES IN AQUEOUS SOLUTION. Hutin, M.-F. (Nancy-1 Univ., 54 (France)). Bull. Soc. Chim. Fr.; No. 3, 463-466(Mar 1975). (In French).

Uranyl and periodate ions in alkaline medium (2N KOH), combine to give a complex with a well-defined optical density that enables the uranyl ions to be determined. The molal extinction coefficient can be calculated (53 D.O.L. $mole^{-1} \cdot cm^{-1}$; at 450 nm). This method, which is selective, allows concentrations of the order of 10^{-3} ion UO_2^{2+} to be determined with the accuracy inherent to colorimetry. The complex obtained is metastable and has not been isolated in the precipitated state. (FR)

2580 GRAVIMETRIC ESTIMATION OF MOLYBDENUM BY 2-AMINO-1-CYCLOPENTENE-1-DITHIO-CARBOXYLATE. Pattanaik, K. C.; Chakraborty, B. R. (Fertilizer Corp. of India Ltd., Sindri). Technology (Sindri); 11: No. 2-3, 303-304(1974).

Molybdenum can be determined quantitatively from its soluble salt by using ammonium-2-amono-1-cyclopentene-1-dithio carboxylate. The diamagnetic property of molybdenum complex also indicates the octahedral structure of the complex and the characteristics of the compound are established. As the ligand forms a stable complex with molybdenum then this ligand can very well be used in the gravimetric determination of molybdenum. (auth)

2581 METHOD OF OXYGEN ISOTOPE ANALYSIS OF MILLIGRAM QUANTITIES OF WATER USING CO_2-H_2O EQUILIBRATION. Suzuoki, T.; Itoh, T. (Tokyo Univ. of Education (Japan). Faculty of Science). Shitsuryo Bunseki; 22: No. 2, 135-141(Jul 1974).

A rapid and precise method of ^{18}O analysis for milligram quantities of water by using a modified CO_2-H_2O equilibration technique at 1210 and 1410°C was developed. The reproducibility in ^{18}O analyses was found to be ±0.1‰, which is compared favorably with the methods reported previously. There are no measurable errors due to the memory effect and oxygen isotope exchange between CO_2-H_2O mixture and instrument glass. An aliquot of a water sample equilibrated with CO_2 for ^{18}O analysis can be used subsequently for D analysis. (auth)

2582 MASS SPECTROMETRY OF TRACE METALS USING CHELATE COMPOUNDS. Recent Development of Stable Isotope Dilution Technique Using Beta-Diketonates. Tsuge, S.; Takeuchi, T. (Nagoya Univ. (Japan). Faculty of Engineering). Kagaku No Ryoiki; 28: No. 7, 587-594; v. 28(8) p. 642-649(Jul 1974). (In Japanese)

Explanation is made on the stable isotope dilution technique (SIDT) and on the nature of β-diketone chelate compounds. According to the SIDT, samples are first chemically treated to convert the element to be determined into volatile or sublimable compounds. By mass spectroscopy, a pair is chosen from the group of peaks of the fragments that contain the stable isotopes of the element. The number of the stable isotope must be more than 1. The intensity ratio of the pair is measured, and the isotopic ratio of the element to be determined is calculated. The same treatment as before is given to condensed isotopes of the same element as that in the sample, but with different isotopic abundance. The intensity ratio of the same pair of peaks on the spectrum as that for the sample is determined. Now a definite amount of the condensed isotopes is added to a known amount of the sample. After the same treatment as described above, the intensity ratio of the same peak on the spectrum is determined and the isotopic ratio is calculated. Then the content of the element in the sample is calculated. β-diketone compounds are especially suitable to convert metallic elements into sublimable or volatile compounds. (JA)

2583 DETERMINATION OF URANIUM IN STEEL. Kysil, B. Hutn. Listy; 29: No. 10, 735-738(Oct 1974). (In Czech.).

A new method of determining the content of U in steel is presented. U is separated from its solution by SiO_2 gel, and determined photometrically using the reagent Arsenazo III. The lowest amount of U determined was 5ppM in steel. The accuracy of the method was dependent on U content. (Metals Abstr.)

2584 PHOTOMETRIC DETERMINATION OF NIOBIUM IN ZIRCONIUM ALLOYS. Slama, J. Hutn. Listy; 29: No. 10, 738-739(Oct 1974. (In Czech).

The photometric determination of the Nb content of Zr alloys, using 4–(2 pyridylazo) resorcinol, at a wavelength of 546 nm is

described. The accuracy of the determination was ±1.4%. (Metals Abstr.)

Radiometric and Radiochemical Procedures

Refer also to abstracts 3039, 3282, and 3476.

2585 (AEC-tr-7533/6) NUKLEONIKA. Translation of Nukleonika; 19: No. 6, 505-606(1974). 96p. (TT-74-54003/6). Dep. NTIS $6.00.

2586 DETERMINATION OF LOW PARTIAL RATES AND THE MECHANISM OF THE DISSOLUTION OF MULTICOMPONENT STEELS BY THE METHOD OF GAMMA SPECTROMETRY. Rodin, N. N.; Plaskeev, A. V.; Dembrovskii, M. A.; Kolotyrkin, Ya. M.; Knyazheva, V. M. Zashch. Metal.; 9: No. 4, vp(1973).

Highly sensitive γ-spectrometric methods, permitting a selective analysis of small quantities of Fe, Cr, Ni, Mo, Cu, and Mn present simultaneously in solution are described. The methods were used to study the kinetics of the dissolution of the components of steel E1943. (Corros. Abstr.)

2587 SIMULTANEOUS ESTIMATION OF MICROGRAM AMOUNTS OF METALS BY X-RAY FLUORESCENCE ANALYSIS AFTER SOLVENT EXTRACTION AND CONCENTRATION ON FILTER PAPER. Iwasaki, K.; Tanaka, K.; Takagi, N. (Industrial Research Inst. of Kanagawa Prefecture, Yokohama (Japan)). Jpn. Anal.; 23: No. 10, 1179-1184(Oct 1974). (In Japanese)

A technique for the preparation of specimens was developed for the benefit of solvent extraction and subsequent x-ray fluorescence analysis of microgram amounts of metals. It involves the extraction of metal chelates by an organic solvent, dropping the whole extract on a filter paper, concentration of the dispersed chelates quantitatively into a definite area most intensely excited by x-ray beam by permeation with an adequate solvent from the edge of the filter paper, and finally the measurement of the strength of fluorescent x-ray for the specimen thus obtained. Two kinds of extractions were used for the establishment of qualitative and quantitative analysis of multi-component trace metals: (1) Metal diethyldithiocarbamates (DEDTC) by chloroform from a tartrate-acetate solution (pH 5 or 6) for 20 metals (V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Pd, Ag, Cd, In, Sb, Te, Hg, Tl, Pb, and Bi). (2) Metal cupferrates by chloroform from a dilute hydrochloric acid solution for Ti, V, Fe, Zr, Mo, Sn, Sb, and Hf. Qualitative analysis could be done simultaneously on a spectrum chart for 20 metals (DEDTC extraction) and 8 metals (cupferron extraction). The detectable amount was 1 μg or less for several metals and 3 to 5 μg for all the others. Quantitative analysis was examined for the DEDTC extraction of Fe, Ni, Cu, Zn, Cd, and Pb, and a good linearity was obtained between the metal amount and x-ray intensity with the respective detection limit of 0.4, 0.2, 0.4, 0.3, 3.5, and 1.8 μg. For the accurate analysis, background correction and absorption effect were discussed. (auth)

2588 IDENTIFICATION OF UNIDENTIFIED GAMMA-RAY OF RADIOACTIVE IODINES YIELDED BY DIRECT FISSION. Ohtou, Y.; Nakaoka, A.; Koyama, H. (Central Research Inst. of Electric Power Industry, Komae, Tokyo (Japan). Technical Lab. No. 1). Denryoku Chuo Kenkyusho Gijutsu Daiichi Kenkyusho Hokoku; No. 74028, 1-8, 1-23(Oct 1974). (In Japanese)

The correlation between the radioactive concentration and the decay constant of some radioactive iodines is generally applied to detect fuel damage. Consequently, it is important to measure radioactive iodines in primary coolant for fuel management of light water reactors. The information for the energy and the intensity of gamma-rays emitted from radioactive iodines are found in Table of Isotopes and Nuclear Data Tables, but it is impossible to assure the reliability of these data for lack of the details of experimental methods. The energy and the intensity of gamma rays emitted from radioactive iodines were identified by the half-life method in order to ascertain the accuracy of published data and to select the optimum condition for the determination of radioactivity of the iodine. Radioactive iodine in primary coolant in light water reactor was extracted with carbon tetrachloride, and then precipitated as silver iodine. The radioactivity of the precipitation was measured with the Radiation Statistical Analyzer (Quanta System). The energy and the intensity of gamma emitted from radioactive iodines were found as follows; 641.2 kev of ^{131}I, 607.5 kev of ^{133}I, 1743.1 kev of ^{134}I and 2045.9, 2255.5, 2406.6 and 2408.7 kev of ^{135}I. More accurate half-lives of ^{132}I, ^{133}I, ^{134}I, and ^{135}I were determined as 2.12 ± 0.15 h 20.2 ± 0.7 h, 51.3 ± 0.7 m and 6.31 ± 0.13 h, respectively. The necessary cooling time on each energy of the radioactive iodines was determined in order to obtain available data from the decay of each radioactive iodine. Representative gamma energy of each radioactive iodine was proposed as follows; 364.6, 667.4, 874.9, 847.0, and 1260.5 kev for ^{131}I, ^{132}I, ^{133}I, ^{134}I, and ^{135}I, respectively. (auth)

2589 mu^{+-} PRECESSION STUDIES OF MAGNETIC MATERIALS. Kossler, W. J. (College of William and Mary, Williamsburg, VA). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 788-792(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

The muon has recently begun to be used to study solid state. A review of this work to date and a description of current and proposed experiments is made. The use of this probe is analogous to perturbed angular correlation with several special advantages: the muon is produced approximately 100 percent polarized, the decay mu yields e + nu + nu produces highly anisotropic (1 + ⅓ cos theta) energetic charged leptons (up to 50 MeV), the lifetime of the muon (2.2 mu s) is sufficiently long for easy timing and short enough for high count rates. The mu^{+} behaves as a light hydrogen ion and is thus the simplest impurity problem. Consequently the use of muons should not only yield fundamental solid state information, but also contribute to the understanding of radioactive ion implantation, particularly in the case of ferromagnetic samples. (auth)

Separation Procedures

Refer also to abstracts 2689, 3121, and 3535.

2590 (AECD/MISC-4, pp 6-8) RECOVERY OF URANIUM AS A BY-PRODUCT FROM TRIPLE SUPERPHOSPHATE FERTILIZER PRODUCTION. Awwa, M. A.; Huq, A. M. S.; Maroof, F. B. A. (Atomic Energy Center, Dacca, Bangladesh). Dec 1974.

In annual technical report, July 1972–June 1973. (Atomic Energy Center, Dacca (Bangladesh)).

2591 (DP-159) PRECIPITATION OF NEPTUNIUM OXALATE AND CALCINATION TO NEPTUNIUM OXIDE. Porter, J. A. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. (USA). Savannah River Lab.). Jul 1961. Contract AT(07-2)-1. 27p. Dep. NTIS $5.00.

Declassified 11 Jun 1975.

Two procedures were developed for the quantitative precipitation of neptunium(IV) oxalate that filters rapidly and is readily calcined to the oxide. In the preferred procedure the oxalate was precipitated at elevated temperature from solutions of low acidity. In the alternative procedure the oxalate was precipitated at room temperature from solutions of higher acidity. Neptunium oxide was prepared by calcining the oxalate at 500°C in a flowing stream of air or nitrogen. (auth)

2592 (ORNL-TM-4777, pp 166-202) CHEMICAL ENGINEERING RESEARCH. Jul 1975.

In experimental Engineering Section semiannual progress report. (Oak Ridge National Lab., Tenn. (USA)).

Contractor development studies have included measurements of the mass transfer rate in open bubble columns and stirred-interface (Lewis cell) contactors, as well as flooding rate measurements in packed columns filled with Goodloe packing. Results of recent studies of tritium sorption from liquid metals are summarized. Although several hydride-forming metals such as yttrium and zirconium look promising as sorbers for recovering tritium from blanket or coolant fluids of controlled thermonuclear reactors, these results show that oxide films can limit sorption rates to impractical levels. Preliminary tests with nickel-coated zirconium indicate that sorption rates can be improved; however, no practical material has been tested thus far. (auth)

2593 (ORNL-tr-4036) U(IV) EXTRACTION FROM AQUEOUS HNO_3 SOLUTION BY QUATERNARY AMMONIUM HYAMINE-1622. Schmid, E. R.; Juenger, E. Translated by M. Gerrard from Radiochim. Acta; 17: No. 3, 153-158(1972). 16p. Dep. NTIS $4.50.

The distribution of uranium (IV) between aqueous nitric acid solutions and solutions of the quaternary ammonium salt Hyamine-1622 (approximately p-diisobutylphenoxyethoxyethyl-dimethyl-benzyl-ammonium as nitrate), using various organic solvents, is described. Uranium (IV) is well extracted. The influence of a number of factors on the uranium(IV) distribution ratio was investigated systematically. In the organic phases, uranium(IV) was present always as a hexanitrato complex. (auth)

2594 CHEMISTRY OF PROTACTINIUM, 11. A Study of the Solvent Extraction of Protactinium(IV) Reduced With Europium (II) From a Perchloric Acid Solution, Using Thenoyltrifluoroacetone as the Extractant. Kawasuji, I.; Sato, A.; Suzuki, S. (Tohoku Univ., Sendai (Japan). Research Inst. for Iron, Steel, and Other Metals). Bull. Chem. Soc. Jpn.; 47: No. 9, 2213-2216(Sep 1974).

Europium(II) was found to be an excellent reductant for reducing protactinium in microquantities to the tetravalent state. The behavior of Pa(IV) in the perchloric acid solution was investigated

by the TTA-benzene extraction method. It was found that the $PaOH^{3+}$ ion existed predominantly in a 0.03-3M perchloric acid solution at the ionic strength of 3. The reaction of TTA extraction may proceed as: $PaOH^{3+} + 4HA = PaA_4 + H_2O + 3H^+$ or $PaOH^{3+} + 4HA = Pa(OH)A_3(HA) + 3H^+$. The distribution ratio of Pa(IV) in the system using Eu(II) as the reductant is about ten times as large as that in the system using Cr(II) as the reductant. It was considered that a nonextractable complex may be formed between Pa(IV) and Cr(III), while such a complex may not be formed when Eu(II) is used as the reductant. (auth)

2595 ELUTION OF La, Ce, Pr, Nd, Sm, Eu, AND Gd FROM ANION EXCHANGE RESIN COLUMNS WITH USE OF ETHANOL-FORMIC ACID-NITRIC ACID MIXTURES. Kakihana, H. (Tokyo Inst. of Tech. (Japan). Research Lab. of Nuclear Reactor); Kurokawa, K. Jpn. Anal.; 23: No. 11, 1321-1325(Nov 1974). (In Japanese)

An ethanol–formic acid–nitric acid mixture containing 0.0050 m mol of La, Ce, Pr, Nd, Sm, Eu, or Gd was passed down a column packed with a strong-base anion exchange resin, Amberlyst A29 in the nitrate form (1.1 cm × 21 cm bed), and the rare earths adsorbed on the column were eluted with various mixtures of ethanol, formic acid, and nitric acid. In general the heavier rare earth passed down the column at a faster rate than the lighter one. The most effective compositions of the mixtures for separations of adjoining rare earths were, (1) for Eu and Gd, C_2H_5OH-15 M HCOOH-10 M HNO_3 (80:10:10 volume ratio) (2) for Sm and Eu, C_2H_5OH-10 M HCOOH-7 M HNO_3 (80:10:10) (3) for Sm, Eu, and Gd, C_2H_5OH-15 M HCOOH-7 M HNO_3 (80:10:10) (4) for Nd and Sm, C_2H_5OH-10 M HCOOH-7 M HNO_3 (75:15:10) (5) for Pr, Nd, and Sm, C_2H_5OH-5M HCOOH-7 M HNO_3 (75:20:5) (6) for Ce(III) and Pr, C_2H_5OH-5M HCOOH-7 M HNO_3 (70:25:5) and (7) for La and Ce(IV), C_2H_5OH-5M HCOOH-7 M HNO_3 (70:25:5). (auth)

2596 SEPARATION OF KRYPTON FROM NITROGEN BY THE THERMAL DIFFUSION METHOD. Hirota, K.; Yoshizumi, H.; Tachikawa, Y. (Chiba Inst. of Tech., Narashino (Japan)). Nippon Kagaku Kaishi; 1974: No. 9, 1819-1820(Sep 1974). (In Japanese)

Krypton was separated from its mixture with nitrogen at one atmospheric pressure by use of a thermal diffusion column of the hot-wire type and of an effective length of one meter. When the inner diameters ϕ of the column were 15 and 10 mm, the time required to reach the equilibrium state was 10 ~ 15 min at a wire temperature of 400°C and an initial krypton concentration of about 50%. Degrees of separation at this state defined by $q_c = [C(1-C)]/[C'(1-C')]$ were 125 and 180 when ϕ = 15 and 10 mm, where C and c' denote the krypton concentrations at the bottom and top of the column, respectively. These q_c values are very large and the corresponding equilibrium times very short in comparison to the cases of separation between isotopic molecules, but this result can be explained in terms of the theory of the column. (auth)

2597 APPLICATION OF SYNTHETIC INORGANIC ION EXCHANGERS TO CHEMICAL ANALYSIS, 1. Hydroxides and Hydrous Oxides. Abe, Mitsuo (Tokyo Inst. of Tech. (Japan). Faculty of Science). Jpn. Anal.; 23: No. 10, 1254-1285(Oct 1974). (In Japanese)

259 refs.

The ion-exchanging characterisitcs, advantages and disadvantages of hydroxides and hydrous oxides are reviewed, and examples of their application to chemical analysis are cited. First section deals with inorganic ion exchangers such as active alumina and silica gel which are utilized for thin layer gas chromatography. Second section deals with hydroxides and hydrous oxides of various metals. They are used for gas chromatography and as coagulant for sedimentation. Attention is paid to the researches on adsorption properties, particularly the adsorption properties of K^+ and Cl^- ions on hydroxides and hydrous oxides of various metals. Third section summarizes adsorption characteristics. Fourth section deals with examples of separation. A list of the inorganic separation by ion exchange with hydroxide and hydrous oxides is included. In conclusion, the ion exchange properties of metallic hydroxides and hydrous oxides as well as silica gel and alumina are well known. Specifically, antimonic acid not only has high ion-exchange capacity and chemical resistance, but also has special selectivity, and the application of which is being developed. H-ZrO_2 and H-SnO_2 have amphoteric adsorption, so that new application is expected. Researches for the application of inorganic ion exchange membranes to fuel cells, reverse osmosis, desalting and on radioisotope generators have been performed. (JA)

2598 APPROACH TO INDUSTRIALIZATION ON COLLECTION OF URANIUM IN SEA-WATER. Ogata, N. (Japan Monopoly Corp., Tokyo. Central Research Inst.). Genshiryoku Kogyo; 20: No. 12, 51-56(Dec 1974). (In Japanese)

Research for collecting uranium in seawater was started in Japan in 1967, but it has been interrupted since about 1971 except Shikoku Industrial Laboratory, MITI. Knowledges and experiences obtained so far are introduced, as the research project is going to start again. The methods used for collecting uranium in seawater are briefly reviewed. Methods and apparatuses for adsorption are referred to. The method of flowing seawater through columns charged with particle form adsorbent is suitable for test plants, but cannot be used over 2 cm/sec flow speed. Filter type, fluidized bed type, and cyclone type show good recovery rate, but pumps are required. In pool type, formed adsorbent (particles, films, and nets) is packed in the channels of pools. This method can be used for the dam method utilizing tide. The dam method is estimated at $62 per lb in Japan. Adsorber type idea was contempleted to solve the fault in changing to fresh seawater in tide-utilizing method. Problems in the tide-utilizing dam system may be siting conditions where fresh seawater can be introduced, sufficient tide difference, relatively high temperature, large ground area required, for example 1.57 km^2 of bed area only, the quality and form of adsorbent, unbalance in material account, and the deterioration of adsorbent by repetition of use, the obstruction of adsorption and flow by diatom and green weed, and the effect of titanic acid because of contaminant adsorption. Desorption step must be studied further. (JA)

2599 APPARATUS FOR HYDROGEN REMOVAL. Ono, M.; Kamei, H. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1974-26406/B/. 3 Aug 1970. 3p. (In Japanese)

An apparatus for removing hydrogen (H_2) from such liquid metals as liquid sodium is provided comprising a liquid metal passage and a H_2-removing chamber. The passage is partially enveloped by the chamber through intermediation of an H_2-permeable membrane. The chamber is preliminarily filled with a gas incapable of passing through the membrane and inert to H_2. As the liquid metal flows inside the passage, H_2 diffuses into the chamber through the first membrane, which is then released into the air through the second membrane. This type of apparatus enables H_2 to be removed from liquid metals continuously and semi-permanently. Danger is minimized since the liquid metals will not contact air directly. (JA)

Inorganic, Organic, and Physical Chemistry

Refer also to abstract 4289.

Chemical and Physicochemical Properties

Refer also to abstract 4012.

2600 (AGC-9050-111-65) PROPERTIES OF PRINCIPAL CRYOGENICS. (Aerojet-General Corp., Sacramento, Calif. (USA)). Nov 1965. 112p. Dep. NTIS $6.50.

Hydrogen has many properties that make it a highly desirable rocket propellant. Because of these desirable properties, hydrogen has in recent years reached a position of very great interest in advanced thrust chamber design and development programs. Because of this interest, the ready availability of complete and accurate physical and thermodynamic properties of hydrogen has become a matter of great importance. Similar data are provided for oxygen, nitrogen, and fluorine. The curves and tables were gathered from the best available sources and represent an accumulation of information. The curves are presented in a form that can be used with ease and that will be reasonably accurate. If greater accuracy is required, the original sources may be used. The curves, however, will provide data useful for most engineering purposes in a readily accessible form. (auth)

2601 PREPARATION OF INDOL DERIVATIVES AS RADIOPROTECTIVE AGENTS. I. Chemical Part. Andrieu, L.; Fatome, M. (Centre de Recherches du Service de Sante des Armees, 92-Clamart (France). Div. d'Hygiene Atomique); Bitoun, J.; Granger, R.; Robbe, Y.; Terol, A. (Montpellier-1 Univ., 34 (France)). Eur. J. Med. Chem.-Chim. Ther.; 9: No. 4, 449-452(Jul 1974). (In French).

Heterocyclic iminiums with S-CH_3 were obtained from 3-indolylmethane-thioamide by the action of methyl iodide. The compound 2-amino-ethanethiol gives, with sulfur and two moles of 3-formyl indole, (3'-indoly) 1-carbothioamido (3'-indoly) 2-methyloithio ethane. (FR)

2602 STUDY OF A DIAPHRAGM CELL FOR IONIC TRANSPORT NUMBER MEASUREMENTS WITH RADIOACTIVE TRACERS. Perie, Michele; Perie, Jacques; Chemla, Marius (Paris-6 Univ.,

75 (France)). J. Chim. Phys.; 72: No. 2, 148-152(Feb 1975). (In French).

A diaphragm cell, convenient for transfer number measurements in hydroorganic media by means of radiotracer techniques, was developed. Diffusion and difficulties encountered with conventional porous diaphragms were avoided by using thin teflon membranes, pierced with a few holes of small diameter, 3.10^{-2} cm. The method may conveniently be applied to solutions whose structure is made complex by the presence of several ions or solvant mixtures, and provides results with an accuracy of about 1%. (FR)

2603 THE THERMOMAGNETIC FORCE IN THE NEAR-WALDMANN REGIME FOR CO, N_2, HD, AND CH_4. Davis, L.A. (Department of Physics, Texas A&M University, College Station, Texas 77843). J. Chem. Phys. 63: No. 8, 3307-3311 (15 Oct 1975).

The thermomagnetic force exerted on a disk with surface perpendicular to the heat flux has been measured in the gases CO, N_2, HD, and CH_4 for conditions approximating those assumed by recent theory. Comparison is made with theory and previous experimental work, and the thermomagnetic force is shown to depend upon the surface composition of the disk. (auth)

2604 ELECTROLYTIC CELL FOR HEAVY AND LIGHT WATER. Fujii, I.; Muto, H.; Onodera, K. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1974-10586/B/. 19 Feb 1969. 3p. (In Japanese)

An apparatus for electrolyzing heavy and light water is given to prevent an electrode sealing wire from cutting by improving the construction so as to produce an alkali material adjacent to a cathode and an acidic material adjacent to an anode, and then immediately neutralizing them, using a charged particle accelerator as an ion source. The electrolytic solution uses a potassium sulphate solution of heavy and light water. A portion facing a cathode at the bottom of the cell is built higher than the other portion, on which an anode is so arranged that an alkali material produced at the cathode is immediately neutralized with an acidic material produced at the anode. In one embodiment, the cell bottom is cone shaped. The central portion is built higher than the other portion. At the anode portion is arranged. Cathode is located at the central portion. Heavy water is filled in the cell and the opening is sealed. An isolation cylinder communicates with a blind pipe at the top. Heating wire leads to a terminal. The reactions are $SO_4^{2-} + D_2O \rightarrow D_2SO_4 + 1/2\ O_2$ at the anode; $2K^+ + 2\ D_2O \rightarrow 2KOD + D_2$ at the cathode. KOD drops to the portion immediately and is neutralized. (JA)

Isotope Effects

Refer also to abstracts 2579, 2669, 2673, 2676, and 4034.

2605 FORCE FIELD AND NORMAL MODES OF PLANAR VIBRATIONS OF BENZENE AND ALL DEUTERATED SPECIES. Discussion. Favrot, Jean (Paris-6 Univ., 75 (France); Centre National de la Recherche Scientifique, 94-Thiais (France). Lab. de Chimie Physique). J. Chim. Phys.; 72: No. 3, 297-302(Mar 1975). (In French).

The valence force field obtained for the planar vibrations of benzene was compared with previous works. Interaction force constants concerning bending motions were found more important than in these works. The influence of molecular symmetry, type of substitution, and number of deuterium atoms on the potential energy distribution of stretching CC and bending CCC modes and bending CH or CD modes, was analyzed for all deuterated benzenes. (FR)

2606 OBSERVATION OF ^{13}C–^{14}N DIPOLAR COUPLINGS IN SINGLE CRYSTALS OF GLYCINE. Griffin, R.G. (Francis Bitter National Magnet Laboratory, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139); Pines, A.; Waugh, J.S. J. Chem. Phys. 63: No. 8, 3676-3677 (15 Oct 1975).

Dipolar splittings are normally not observable because the large number of nuclear couplings usually present produces extensive broadening of the NMR lines. In this note the ^{13}C–^{14}N splitting in glycine is observed by using rf fields of sufficient strength to decouple the protons from the magnetically dilute nuclei. (AIP)

2607 DIFFRACTION PATTERN AND STRUCTURE OF AQUEOUS HYDROCHLORIC ACID SOLUTIONS AT 20 °C. Triolo, R.; Narten, A.H. (Chemistry Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). J. Chem. Phys. 63: No. 8, 3624-3631 (15 Oct 1975).

Hydrochloric acid solutions have been studied at concentrations from pure water to saturation with both x rays (HCl/H_2O) and thermal neutrons (DCl/D_2O). Such an extensive study reduces greatly the nonuniqueness of interpretation usually associated with diffraction data from liquids. The structure of D_2O molecules in liquid water is very similar to that found in the vapor phase, the OD distance of 0.955(5) Å being identical to the equilibrium distance in the vapor molecules. The existence of D_3O^+ ions with an OD distance of 1.017(5) Å in concentrated DCl is firmly established. The $D_3O^+(H_3O^+)$ ions are hydrogen bonded to four water molecules with an $H_3O^+\cdots OH_2$ distance of 2.52(2) Å and a $D_3O^+\cdots D$ distance of 1.61(2) Å. The Cl^- ions appear to be four-coordinated by oxygen atoms at a mean distance of 3.13(1) Å, but no pronounced Cl···D distances indicating a well-oriented hydration shell about Cl^- could be identified. (auth)

2608 ROTATIONAL CORRELATION TIMES FOR ETHANOL BY DEUTERON MAGNETIC SPIN–LATTICE RELAXATION. Chen, T.k.; Beyerlein, A.L.; Savitaky, G.B. (Department of Chemistry and Geology, Clemson University, Clemson, South Carolina 29631). J. Chem. Phys. 63: No. 7, 3176-3177 (1 Oct 1975).

The deuterium T_1 relaxation times of perdeuterated ethanol in CCl_4, benzene, and water solutions have been measured. The results are compared with theoretical determinations of the rotational correlation time. (AIP)

2609 A RAMAN SPECTROSCOPIC STUDY OF THE STRUCTURAL ASPECTS OF K_2MgCl_4 AND Cs_2MgCl_4 AS SOLID SINGLE CRYSTALS AND MOLTEN SALTS. Brooker, M.H. (Department of Chemistry, Memorial University of Newfoundland, St. John's, Newfoundland, Canada A1C 5S7). J. Chem. Phys. 63: No. 7, 3054-3061 (1 Oct 1975).

Polarized Raman spectra have been obtained for oriented single crystals of K_2MgCl_4 and Cs_2MgCl_4 at 77 and 298 K. The data is in excellent agreement with factor group analyses based on the space groups $I4/mmm$ (D^{17}_{4h}) and $Pnma$ (D^{16}_{2h}) for the K_2MgCl_4 and Cs_2MgCl_4 crystals. In K_2MgCl_4 the magnesium is surrounded by six chloride ions in a distorted octahedral arrangement with a network structure such that neighboring octahedra share corners. In Cs_2MgCl_4 a discrete tetrahedral $MgCl_4^{2-}$ species is present. The ^{35}Cl–^{37}Cl isotopic splitting of the symmetric stretching mode of the tetrahedral $MgCl_4^{2-}$ species has been resolved at 77 K and is similar to that observed for CCl_4. Raman spectra for the high temperature solids and molten salts suggest that the coordination number of magnesium changes from six in solid K_2MgCl_4 to four in the melt, whereas Cs_2MgCl_4 melts with retention of the $MgCl_4^{2-}$ tetrahedral complex. Additional evidence is presented to support previous reports that the $MgCl_4^{2-}$ tetrahedral species is the principal complex ion in the melts, although a fraction of the magnesium appears to be present in a polynuclear complex, perhaps $Mg_2Cl_6^{2-}$. (auth)

2610 HYDROGEN ABSTRACTION REACTIONS BY ATOMIC FLUORINE. III. TEMPERATURE DEPENDENCE OF THE INTERMOLECULAR KINETIC ISOTOPE EFFECT FOR THE THERMAL $F+H_2$ REACTION. Grant, E.R.; Root, J.W. (Department of Chemistry and Crocker Nuclear Laboratory, University of California, Davis, California 95616). J. Chem. Phys. 63: No. 7, 2970-2979 (1 Oct 1975).

The intermolecular kinetic isotope effect for the title reaction has been investigated using a moderated nuclear recoil technique. The following Arrhenius temperature dependence was obtained: $k_{H_2}/k_{D_2} = (1.04 \pm 0.06)\exp[(382 \pm 35)/RT]$. This result is in quantitative agreement with an independent study based upon a discharge flow reactor method. The advantages and limitations of the nuclear recoil procedure are considered, and relevant literature results are critically reviewed. (auth)

2611 *AB INITIO* STUDY OF SECONDARY ISOTOPE EFFECTS ON MOLECULAR STRUCTURE. Bartell, L.S.; Fitzwater, S. (Chemistry Department, The University of Michigan, Ann Arbor, Michigan 48104); Hehre, W.J. J. Chem. Phys. 63: No. 7, 3042-3045 (1 Oct 1975).

An *ab initio* calculation of a secondary isotope effect on a bond length has been carried out for the first time. Single determinant molecular orbital computations indicate that the mean C–C bond length at 0 °K is longer in C_2H_6 than in C_2D_6 by 0.0015 Å. A comparison with model calculations supports a steric interpretation in which H atoms act as if they are bulkier than D atoms owing to their larger bending amplitudes of vibration. (auth)

2612 MASS-REDUCED QUANTUM NUMBERS: APPLICATION TO THE ISOTOPIC MERCURY HYDRIDES. Stwalley, W.C. (Department of Chemistry, University of Iowa, Iowa City, Iowa 52242). J. Chem. Phys. 63: No. 7, 3062-3080 (1 Oct 1975).

The concept of mass-reduced quantum numbers is introduced and discussed. For a diatomic molecule, the mass-reduced vibrational quantum number $\eta = (v+1/2)/(\mu)^{1/2}$ and mass-reduced rotational quantum number $\xi = J(J+1)/\mu$ are used and exemplified. Isotopically combined methods of potential determination from spectroscopic data follow from introduction of these quantum numbers, e.g., the isotopically combined Rydberg–Klein–Rees (RKR) method. These concepts are applied in detail to the isotopic mercury hydrides. It is shown that mass-reduced functions exist which accurately describe, for example, vibrational spacings $[\Delta G\ (\eta)(=dG/d\eta) = \mu^{1/2}\Delta G\ (v+1/2)]$, rotational constants $[B\ (\eta) \cong dE\ (\eta,\xi)/\ d\xi = \mu B\ (v)]$, and centrifugal distortion

constants [$D(\eta) = \mu^2 D(\nu)$]. The vibrational and rotational mass-reduced functions are used to construct an isotopically combined RKR potential. This potential, when joined to the long-range potential and extrapolated at short range reproduces the energy levels fairly well. In a companion paper, it is shown to yield the energy dependence of the total scattering cross section accurately. It should be noted that many other possible methods for potential determination are inadequate in this case. The interesting pseudocrossing region (~3–5 Å), where an unusual flat shoulder in the potential occurs, is discussed, as are the two loci of barrier maxima (the extra locus arising from this shoulder). In Appendixes A, B, and C, new assignments of the 0–6 band of the *A–X* system of HgD are reported, the long-range C_6 coefficient estimated, and the dissociation energies of HgH and HgD accurately determined to be $D_0 = 3020^{+1}_{-7}$ cm^{-1} and 3207 ± 1 cm^{-1}, respectively. (auth)

2613 ANALYSIS OF THE IR SPECTRA OF ERYTHROMYCIN AND ITS HYDROLYZATES (ERYTHROLOSAMINE, DESOSAMINE, AND CLADINOSE). Dziegielewski, J.; Hanuza, J.; Jezowska-Trzebiatowska, B.; Kuduk-Jaworska, J. (Warsaw Univ.). Bull. Acad. Pol. Sci., Ser. Sci. Chim.; 23: No. 6, 513-529(1975).

The ir spectra of erythromycin and its acid hydrolyzates (erythrolosamine, desosamine, and cladinose) were studied from 200 to 4000 cm^{-1}. By comparing the shapes, intensities and energy sequences of bands particular absorption peaks were assigned to their respective group frequencies. The analysis of the spectra was assisted by providing some comparative data from deuteration of the above compounds and by measuring the spectra of some fragments of these compounds. (auth)

2614 EVIDENCE FOR A REMOTE SECONDARY DEUTERIUM KINETIC ISOTOPE EFFECT ARISING FROM A STERICALLY CONGESTED GROUND STATE. Fry, J. L.; Badger, R. C. (Univ. of Toledo, OH). J. Am. Chem. Soc.; 97: No. 21, 6276-6277 (15 Oct 1975).

In an effort to gain practical information concerning the importance of initial state steric effects in a system in which other modes of intramolecular interaction might be expected to be minimal, a study was made of the kinetic isotope effect associated with the solvolysis of 2-tert-butyl-2-adamantyl p-nitrobenzoate deuterated in the tert-butyl group. The resulting gamma-deuterium isotope effect is composed with those of other substrates undergoing limiting solvolyses in which deuterium is similarly situated in nonhyperconjugative positions. (JGB)

2615 ACID DISSOCIATION OF CHLOROFORM AND PHENYLACETYLENE. Solvent Isotope Effects. Kresge, A. J. (Univ. of Toronto); Lin, A. E. J. Am. Chem. Soc.; 97: No. 21, 6257-6258(15 Oct 1975).

Previously reported results of studies on the detritiation of phenylacetylene were reevaluated. The reported solvent isotope effect on proton transfer fell considerably short of the expected limiting value. Current studies indicate that k/sub D_2O//k/sub H_2O/ equals 1.36 for the detritiation of phenylacetylene and also k/sub D_2O//k/sub H_2O/ equals 1.48 for the experimentally more accessible detritiation of chloroform, another reaction thought to occur by the same mechanism. This value for chloroform is tabulated together with three other isotope effects measured for the hydrogen exchange of this substance catalyzed by hydroxide ion. Analysis of data by the fractionation factor method pointed to reasonably good agreement with the limiting or equilibrium value of 2.4. (JGB)

2616 RHODIUM(I) CATALYSIS IN OLEFIN PHOTOREACTIONS. Salomon, R. G.; El Sanadi, N. (Case Western Reserve Univ., Cleveland). J. Am. Chem. Soc.; 97: No. 21, 6214-6221 (15 Oct 1975).

The photorearrangement (254 nm) of 1,5-cyclooctadiene (1) in the presence of rhodium(I) chloride to give 1,4-cyclooctadiene (4) was found by deuterium labeling to involve an intramolecular [1,3] shift of hydrogen. A rate-determining cleavage of an allylic C–H bond is indicated by a deuterium isotope effect, k/sub H// k/sub D/ equals 1.55 +- 0.03 for the 1 yields 4 rearrangement. The acyclic 1,5-diene, 3,3-dimethyl-1,5-hexadiene (8), rearranges in the presence of rhodium(I) chloride upon uv irradiation (254 nm) to give cis-3,3-dimethyl-1,4-hexadiene (10) and the trans isomer 11 in a 1:4 ratio, respectively. This observation supports a mechanism for the photorearrangement of olefins catalyzed by rhodium(I) involving an initial photodissociation of one of two rhodium(I) coordinated carbon-carbon double bonds. This results in an increase in the coordinative unsaturation of rhodium(I) and enhances the proclivity of this d/sub s/ metal atom toward oxidative addition of an allylic C–H bond. A eta^3-allylrhodium hydride intermediate then gives rearranged olefin by reductive elimination. Lastly, a novel photochemical, rhodium(I) catalyzed hydrogen transfer is reported which gives cyclooctene (7) from cyclooctadienes under unprecedentedly milk conditions. (auth)

2617 REARRANGEMENTS OF TOLUENE AND CYCLOHEPTATRIENE CATIONS. Baldwin, M. A.; McLafferty, F. W.; Jerina, D. M. (Cornell Univ., Ithaca, NY). J. Am. Chem. Soc.; 97: No. 21, 6169-6174(15 Oct 1975).

The losses of CH_3 and CH_5 from the gaseous toluene cation (1) were studied using seven isotopic isomers of I and two of cycloheptatriene (2) utilizing high resolution (1:50000) measurement of the abundance of the isobaric ionic products. Four distinct isomerization pathways, competitive with other I reactions, can be identified: (i) scrambling of the ring hydrogen atoms without involvement of the methyl group; (ii) isomerization I reversible 2 possibly through norcaradiene (7) as an intermediate; (iii) single exchange of an alpha-H and ring-H, possibly through methylenecyclohexadiene (8) as an intermediate; and (iv) complete scrambling of carbon as well as hydrogen atoms, possibly through opening of the aromatic ring. Reaction ii appears to involve the tightest activated complex, and i and ii the lowest activation energy; iii is intermediate, while iv has the loosest activated complex and highest activation energy. An additional pathway for the isomerization of 2, possibly through bis(methylene)cyclopentene, is also indicated. (auth)

2618 REEXAMINATION OF THE SECONDARY alpha-DEUTERIUM ISOTOPE EFFECT IN THERMOLYSIS OF 1,1'-DIPHENYLAZOETHANE. Mechanistic Consequences for Related Compounds. Scheppele, S. E.; Grizzle, P. L.; Miller, D. W. (Oklahoma State Univ., Stillwater). J. Am. Chem. Soc.; 97: No. 21, 6165-6169(15 Oct 1975).

Secondary alpha-deuterium isotope effects were obtained for the thermal decomposition of 1,1'-diphenylazoethane (I) and 1,1'-diphenylazoethane-1,1'-d_2 (I-d_2) at 103.90°. Samples of I and I-d_2 prepared by (a) $LiAlH_4$ and $LiAlD_4$ reduction of 1,1'-dichloro-1,1'-diphenylazoethane are designated as I-1, and I-d_2-1, respectively, and (b) catalytic hydrogenation and deuteration of acetophenone azine are specified as I-2 and I-d_2-2, respectively. An alpha effect of 1.195 +- 0.006 was obtained from I-1 and I-d_2-1 upon correction of k$_{11}$/k/sub D/ equals 1.191 +- 0.006 for 0.040 +- 0.002 atoms of alpha protium. An alpha effect of 1.198 +- 0.014 was obtained from I-2 and I-d_2-2 upon correction of k/sub H// k/sub D/ equals 1.159 +- 0.010 for 0.415 +- 0.016 atoms of alpha protium and 0.245 +- 0.105 atoms of beta deuterium. Thus, the isotope effect in thermolysis of I is 1.194 rather than 1.27 at 105.28°. Nitrogen evolution experiments verified that I-1 and -2, I-d_2-1 and -2, I-ring-d_{10}, meso-1,1',2,2'-tetraphenylazoethane (IV), meso-IV-d_2, 1,1'-diphenylazobutane (V), V-d_2, 2,2'-dimethoxy-1,1'-diphenylazoethane (VI), and VI-d_2 undergo 98–100 percent decomposition. The previous conclusion that a simultaneous one-step mechanism obtains for thermolysis of these compounds is consistent with an alpha effect of 1.195 for I. The alpha effects previously obtained for IV-VI are reinterpreted in terms of the result obtained for I. For I, the transition state model which reproduces an alpha effect of 1.27 and the primary nitrogen effect should be consistent with a k/sub H//k/sub D/ of 1.195 if the H–C–N bending force constant is ca. 0.33 mdyn A/(rad)^2 rather than 0.23 mdyn A/(rad)^2. (auth)

2619 ROLE OF CAGE RETURN IN THE DETERMINATION OF THE SOLUTION PHASE DEUTERIUM ISOTOPE EFFECT DURING HYDROGEN ABSTRACTION REACTIONS OF BROMINE ATOMS. Tanner, D. D.; Ochiai, T.; Pace, T. (Univ. of Alberta, Edmonton). J. Am. Chem. Soc.; 97: No. 21, 6162-6165(15 Oct 1975).

The intermolecular deuterium isotope effect for the photoinitiated bromination of cyclohexane and perdeuteriocyclohexane was determined in the vapor phase and in solution. Under conditions where the radicals formed do not transfer with hydrogen or deuterium bromide, a value for the vapor phase reaction of k/sub RH//k/sub RD/ equals 5.4 +- 0.2 (20.8°) was found. In solution at concentrations of bromine (0.07–3.6 M) which are high enough to stop the transfer of the radicals that are free of the solvent cage, with the low concentrations of hydrogen or deuterium bromide formed at low conversion, the value obtained for k/sub RH//k/sub RD/ equals 4.3 +- 0.2. The difference between the vapor phase and solution results is attributed to a cage reversal reaction, between the radical hydrogen bromide pair, that is competitive with diffusion. At concentrations of molecular bromine (10–18 M) that are high enough to scavenge radicals from the solvent cage, the value obtained for k/sub RH//k/sub RD/ is the same as that found in the vapor phase. Under conditions where mixtures of the reactants (C_6D_{12}:C_6H_{12}:Br_2, 1:1:1) were allowed to completely react the value determined for k/sub RH// k/sub RD/ equals 3.1 +- 0.01 can be attributed to both internal and external reversal reactions. (auth)

2620 RAMAN AND DEPOLARIZED RAYLEIGH SCATTERING IN THE LIQUID STATE: REORIENTATIONAL MOTIONS AND CORRELATIONS IN ORIENTATION FOR

SYMMETRIC TOP MOLECULES. Patterson, G.D.; Griffiths, J.E. (Bell Laboratories, Murray Hill, New Jersey 07974). J. Chem. Phys. 63: No. 6, 2406-2413 (15 Sept 1975).

Reorientational motions perpendicular to the major axis of symmetric top molecules in the liquid state have been examined as a function of temperature by investigating isotropic and anisotropic Raman scattering vibrational band contours. These studies yield information about single-molecule reorientation for the systems C_6H_6, C_6D_6, CH_3CN, CD_3CN, CH_3I, $DCCl_3$, and $HCBr_3$. Depolarized Rayleigh scattering measurements on the same systems, also as a function of temperature, are combined with data on single particle reorientations to yield information about correlations in orientations between pairs of molecules. These correlations between molecules are found to be important for most symmetric top molecules in the liquid state and the temperature dependence of the Raman and Rayleigh band shapes and bandwidths suggest that hard core forces dominate the cooperative motions in the systems studied. (auth)

2621 SPECTRA AND STRUCTURE OF ORGANOPHOSPHORUS COMPOUNDS. XIV. INFRARED AND RAMAN SPECTRA, VIBRATIONAL ASSIGNMENT AND THE ASYMMETRIC POTENTIAL FUNCTION FOR ETHYLPHOSPHINE AND ETHYLPHOSPHINE-d_2. Durig, J.R.; Cox, A.W. Jr. (Department of Chemistry, University of South Carolina, Columbia, South Carolina 29208). J. Chem. Phys. 63: No. 6, 2303-2310 (15 Sept 1975).

The infrared spectra of gaseous and solid $CH_3CH_2PH_2$ and $CH_3CH_2PD_2$ have been recorded from 200 to 3500 cm^{-1}. The Raman spectra of gaseous, liquid, and solid $CH_3CH_2PH_2$ and $CH_3CH_2PD_2$ have been recorded from 100 to 3500 cm^{-1}. The *gauche* and *trans* isomers have been observed in the fluid phases and only the *trans* exists in the solid state. A vibrational assignment of the 24 normal modes has been made. Fundamental and hot band transitions have been observed for both the methyl and phosphino torsions. The methyl barrier in the *trans* d_0 molecule was determined to be 3.74 ± 0.05 kcal/mole and 3.14 ± 0.05 for the *gauche* d_0 molecule. The potential function for internal rotation around the C–P bond in $CH_3CH_2PD_2$ was determined and the following potential constants found: $V_2 = 207 \pm 6$ cm^{-1}, $V_3 = 785 \pm 5$ cm^{-1}, and $V_6 = -25 \pm 3$ cm^{-1}. The energy difference between the potential energy minima of the *gauche* and *trans* conformations is 150 cm^{-1}, the *trans* being the more stable form. The calculated *gauche–gauche* barrier is 635 cm^{-1} (1.82 kcal/mole) and the *trans-gauche* barrier is 944 cm^{-1} (2.70 kcal/mole). A similar potential function was determined for the $CH_3CH_2PH_2$ isomer but the fit to this one-dimensional model was not as good as that for the deuterium compound probably because of greater coupling in the light molecule. (auth)

2622 FLOW-TUBE STUDIES OF VIBRATIONAL ENERGY TRANSFER IN HF(v)+HF, DF(v)+HF, AND DF(v)+D_2 SYSTEMS. Kwok, M.A.; Wilkins, R.L. (The Aerospace Corporation, El Segundo, California 90245). J. Chem. Phys. 63: No. 6, 2453-2460 (15 Sept 1975).

A medium-pressure (1 Torr), large-diameter (10 cm) flow tube has been used to measure rate coefficients at 298 °K for (a) total relaxation (sum of vibrational–vibrational and vibrational–rotational, translational processes) of HF(v=1, 2, 3, 4, and 5) by HF, (b) relaxation of DF(v=1, 2, 3, and 4) by HF, and (c) over-all relaxation of DF(v=1, 2, 3, and 4) by D_2. The chemically produced vibrationally excited HF or DF species have been studied by monitoring their vibrational–rotational emission in a fast-flow system. The rate coefficient for the relaxation of HF(1) by HF is 5.3×10^4 $sec^{-1} \cdot Torr^{-1}$. The measured rate coefficients for the deexcitation of HF(v=2, 3, 4, and 5) by HF are 5.3×10^5, 8.5×10^5, 8.8×10^5, and 2.8×10^5 $sec^{-1} \cdot Torr^{-1}$, respectively. The rate coefficients for the vibrational–rotational, translational deexcitation from the upper vibrational levels of DF(v) by HF are found to have a nonlinear vibrational dependence. The rate coefficient for the relaxation of DF(v=1) by D_2 is 1.35×10^4 $sec^{-1} \cdot Torr^{-1}$. (auth)

2623 MATRIX REACTIONS OF ALKALI METAL CHLORIDE SALTS AND HCl AND DCl: INFRARED SPECTRA OF THE $M^+HCl_2^-$ AND $M^+DCl_2^-$ ION PAIRS. Ault, B.S.; Andrews, L. (Department of Chemistry, University of Virginia, Charlottesville, Virginia 22901). J. Chem. Phys. 63: No. 6, 2466-2472 (15 Sept 1975).

The matrix reactions of alkali metal chloride salts and HCl and DCl have been investigated in argon matrices, as well as the reaction of lithium metal with HCl and DCl. From each reaction product a single intense band was observed which has been assigned to the antisymmetric stretch ν_3 of the HCl_2^- and DCl_2^- anions in the $M^+HCl_2^-$ and $M^+DCl_2^-$ ion pairs. Comparisons to literature spectra, in conjunction with quartic deuterium shifts, indicate that the anion has a linear, centrosymmetric geometry in the isolated ion pair. A *rough estimate* for the bond strength of the hydrogen bond in this anion is 18 ± 2 kcal/mole. Further, comparison to the spectra of earlier workers indicates that bands previously asigned to the HCl_2 radical are best reassigned to the isolated HCl_2^- anion. (auth)

2624 A REFINEMENT OF THE STRUCTURE OF DEUTERIUM PEROXIDE. Prince, E. (Institute for Materials Research, National Bureau of Standards, Washington, DC 20234); Trevino, S.F.; Choi, C.S.; Farr, M.K. J. Chem. Phys. 63: No. 6, 2620-2624 (15 Sept 1975).

The structure of deuterated hydrogen peroxide, D_2O_2, at -15 °C was refined by least-squares methods from three dimensional neutron diffraction data. The data were fitted to two models, one with conventional anisotropic temperature factors and the other with the molecule treated as a rigid body except for torsional oscillations of the O–D groups about the O–O bond. The weighted agreement indices were 0.030 over 106 observed reflections for the conventional model and 0.032 over 102 reflections for the rigid body model. The structure is tetragonal, space group $P4_12_12$ or $P4_32_12$, with $a = 4.035$ Å, $c = 7.97$ Å, $Z = 4$. Position parameters for the two models are essentially the same. The O–O distance in the molecule, 1.455(2) Å, is identical to that found in H_2O_2, but the O–D bond is about 0.015 Å shorter than the O–H bond, 0.993 Å as compared with 1.008 Å when corrected for thermal motion by the riding model. The O–O distance corrected for thermal motion in the rigid body model is 1.49 Å, in fair agreement with the value 1.48 Å found in the vapor phase. (auth)

2625 THE MOLECULAR ZEEMAN AND HYPERFINE SPECTRA OF LiH AND LiD BY MOLECULAR BEAM HIGH RESOLUTION ELECTRIC RESONANCE. Freeman, R.R.; Jacobson, A.R.; Johnson, D.W.; Ramsey, N.F. (Lyman Laboratory of Physics, Harvard University, Cambridge, Massachusetts 02138). J. Chem. Phys. 63: No. 6, 2597-2602 (15 Sept 1975).

The molecular Zeeman spectra of LiH and LiD in the $^1\Sigma$ ground electronic state have been measured in the first rotational state ($J = 1$) and zeroth vibrational state ($v = 0$) by molecular beam electronic resonance. By fitting the observed resonance lines of several different magnetic fields to an appropriate Hamiltonian, values for the rotational g factor (g_J), the anisotropies of the nuclear shieldings ($\sigma_{TH}, \sigma_{TLi}$), and the anisotropy of the molecular magnetic susceptibility (ξ_T) were measured. The results are

Parameter	Li^7H	Li^7D
$g_J(\mu_B/J\mu_N)$	($J = 1, v = 0$)	($J = 1, v = 0$)
σ_{TLi} (ppm)	-0.65842(17)	-0.27674(11)
σ_{TH} (ppm)	-22(6)	-19(15)
σ_{TD} (ppm)	-5(5)	
$\xi_T(10^{-30}$ erg/G^2)		-39(62)
	+4.24(30)	+4.33(47)

In order to fit the observed magnetic field spectra, accurate values of the hyperfine constants were required. The hyperfine spectra of several (J, v) states of LiH and LiD were measured. The results are

Parameter	Li^7H			Li^7D
	($J = 1, v = 0$)	($J = 1, v = 1$)	($J = 2, v = 0$)	($J = 1, v = 0$)
eqQ_{Li} (kHz)	346.780(36)	330.8(4)	346.64(5)	348.942(37)
eqQ_D (kHz)	...	...	...	34.213(33)
C_{Li} (kHz)	10.054(7)	9.88(4)	10.034(3)	5.682(5)
C_H (kHz)	-9.345(27)	-8.87(20)	-9.31(2)	...
C_D (kHz)	...	...	...	- 0.819(6)
C_3 (kHz)	11.346(7)	11.03(8)	11.329(12)	1.7430(70)
C_4 (kHz)	0.135(10)	0.17(4)	0.160(5)	0.005(10)

Numbers in parentheses are the uncertainties in the final figures. (auth)

Isotope Exchange and Isotope Separation

Refer also to abstracts 2581, 3127, and 4069.

2626 PROCESS FOR THE SEPARATION OF ISOTOPES. Jepson, B. E. (to USAEC, Washington, D. C.). French Patent 2,214,509/A/. 17 Jan 1974. 17p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 20 Jan 1973, USA.

The procedure is characterized by placing a feed solution containing the isotopes in contact with a macrocyclic polyether solution in order to form a macrocyclic polyether complex with one of the isotopes and the separation of this macrocyclic polyether from the solution impoverished in one of the isotopes. The equipment used contains the inlet for the feed solution to an exchange column and different processing devices. The separated isotopes are recovered in reservoirs. Such a procedure is particularly convenient for the separation of the isotopes of Na, K, and other elements. (tr-FR)

2627 THE TRITIUM EXTRACTION PLANT OF THE LAUE LANGEVIN INSTITUTE. Pautrot, P. (Institut Max von Laue – Paul Langevin, 38 – Grenoble (France)); Arnauld, J. P. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Service de Genie Chimique). pp 82-83 of Nuclear Energy Maturity.

Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975).

The tritium extraction plant of the Laue-Langevin Institute is first unit in operation to combine extraction of hydrogen and tritium from heavy water. The mean flux of thermal neutrons in the heavy water of the high flux reactor is equal to $1.8\ 10^{14}$ n · cm^{-2} · sec^{-1}, which leads to formation of tritium so that the activity of the heavy water would exceed 80 Ci/liter. The tritium extraction unit allows the activity to be stabilized at <2 Ci/liter. The principle of the operation is the following: catalytic exchange allowing the transfer of hydrogen and tritium from heavy water to the deuterium and fractional distillation of deuterium allowing the elimination of HD at the head and DT at the foot of the column. The startup of the plant, the difficulties encountered, and the operation conditions are presented. (FR)

2628 ISOTOPIC EXCHANGE BETWEEN ^{204}Tb(I) AND Tb(III) IN WATER-ETHANOL AND WATER-GLYCEROL MEDIA. Cecal, Al.; Schneider, I. A. (Universitatea Al. I. Cuza, Iasi (Romania)). Rev. Chim. Miner.; 11: No. 6, 722-725(1974)). (In French).

The isotopic exchange reaction between ^{204}Tl(I) and Tl(III) was studied in a mixed solvent reaction medium of water-ethanol and water-glycerol. It appears that the exchange rate decreases with the concentration increase of the nonaqueous solvent in the mixture. (FR)

2629 THREE-DIMENSIONAL QUANTUM MECHANICAL STUDIES OF $D+H_2 \rightarrow HD+H$ REACTIVE SCATTERING. II. Choi, B.H.; Tang, K.T. (Department of Physics, Pacific Lutheran University, Tacoma, Washington 98447). J. Chem. Phys. 63: No. 7, 2854-2860 (1 Oct 1975).

Three-dimensional quantum mechanical calculations are carried out for the reactive scattering of $D+H_2 \rightarrow DH+H$ on the Yates-Lester potential surface. The differential and total cross sections as well as the *S*-matrix elements are obtained and are compared with the corresponding results obtained on the Porter-Karplus potential surface. The differential cross sections and the distributions over final angular momentum states are in much better agreement with the experimental measurements than the previous results obtained on the Porter-Karplus surface. However, the calculated threshold energy for the reaction seems too high whereas the threshold on the Porter-Karplus potential seems too low. These dynamic attributes are discussed in terms of the two-body potentials between the atom and the molecule. (auth)

2630 SULFUR ISOTOPE ENRICHMENT BY DISSOCIATIVE ELECTRON ATTACHMENT. Allen, J.E. Jr.; Keefer, D.R.; Person, W.B. (University of Florida, Gainesville, Florida 32611). Appl. Phys. Lett. 27: No. 8, 474-475 (15 Oct 1975).

A mechanism is proposed for sulfur isotope enrichment experiments with lasers combining the selective vibrational heating capabilities of the laser with the electron attachment properties of the SF_6 molecule. It is suggested that isotope enrichment may be achieved by selective vibrational heating of one isotopic molecule by the laser, followed by its dissociative electron capture and subsequent removal from the mixture. A reasonable estimate for the extent of selective vibrational heating, together with a slight extrapolation of the known temperature dependence for the SF^-_5/SF_6^- branching ratio, indicates that enrichment ratios of the order of 4500 may be achievable by this process. (auth)

Feed Materials Processing

2631 (EIR-289) EXTRACTION OF URANIUM, THORIUM, AND OTHER METALS FROM GRANITE. Huwyler, S.; Rybach, L.; Taube, M. (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland); Eidgenoessische Technische Hochschule, Zurich (Switzerland)). Sep 1975. 67p. (In German). Dep. NTIS (US Sales Only) $5.00.

It is shown that within the igneous rocks the granites have the highest uranium and thorium contents. These elements are extractable from the rock by means of leaching or chlorination. The energy needed for the extraction is less than 10% of the energy obtainable by burning the uranium and thorium in breeder reactors. In order to increase the economy of the uranium and thorium extraction, other metals (Si, Al,..) are suggested to be extracted from the granite. The reserves of energy contained in the uranium and thorium of the granites make it possible to meet the needs of energy of a future world population of 8-12 milliards requiring 15 kW per capita for thousands of years. (auth)

2632 FLUIDIZED REACTOR REDUCTION OF UF_6 TO UO_2. Welty, R. K. (to Exxon Nuclear Company, Inc.). US Patent 3,906,081. 16 Sep 1975. Filed date 31 May 1973. 4p.

A two stage fluid bed process for converting UF_6 to UO_2 is described. In the first stage UF_6 is converted, preferably in two separate fluid beds, to U_3O_8 by first forming UO_2F_2 solids and treating the UO_2F_2 with steam to produce U_3O_8. The U_3O_8 is reduced at relatively low temperatures i.e., at about 450°C to about 500°C., in a second stage to uranium dioxide. (auth)

2633 URANIUM PROCESSING UPDATE. Iammartino, N. R. Chem. Eng. (N. Y.); 82: No. 5, 88-89(3 Mar 1975).

Several economical methods are available to extract U from various ores and to upgrade recovered material to enriched form. Strong acid leaching can now recover U from difficult ores at lower costs than can traditional dilute acid leaching. Electrolytic reduction techniques eliminate several of the steps ordinarily used to convert recovered U values to uranium hexafluoride, the feed for enrichment plants producing nuclear fuel. The commercial status of these two techniques are described. Cost savings over conventional technology approach 40 percent. (Metals Abstr.)

Radiation Chemistry

Refer also to abstracts 3149, 3154, 3155, 3647, 3660-3663, and 3979.

2634 (AEC-tr-7533/4) NUKLEONIKA. Translation of Nukleonika; 19: No. 4, 275-386(1974). 99p. (TT-74-54003/4). Dep. NTIS $6.00.

2635 (AECD/MISC-4, pp 8-9) MODIFICATION OF THE PROPERTIES OF JUTE. Al-Siddique, F. R. (Atomic Energy Center, Dacca, Bangladesh). Dec 1974.

In annual technical report, July 1972 -June 1973. (Atomic Energy Center, Dacca (Bangladesh)).

2636 (LBL-4000, pp 350-351) HEAVY ION IRRADIATION OF SOLID GLYCINE. Tung, T. L.; Sokol, H. A.; Bennett-Cornies, W.; Welch, G. P.; Garrison, W. M. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

2637 γ-IRRADIATION OF THYMIDINE IN AERATED AQUEOUS SOLUTION. I. Identification of the Hydroxyhydroperoxides. Cadet, Jean; Teoule, Robert (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Lab. de Radiobiologie). Bull. Soc. Chim. Fr.; No. 3, 879-884(Mar 1975). (In French).

The primary products formed from the γ-irradiation of thymidine in aerated aqueous solution are nine nucleosidic hydroperoxides. Determination of the configuration of the eight isomers of 6(or 5)-hydroperoxy-5(or 6)-hydroxy-5,6-dihydrothymidine is based on their specific chemical transformation into the corresponding thymidine-5,6-diol. The position of the peroxy group was determined from mass spectrometric measurements of the hydroxy-hydroperoxides obtained from the [^{18}O]-6-exo-halohydrines. 5-hydroperoxymethyl-2-deoxyuridine was identified by a comparison of its spectroscopic and chemical properties with those of the reference compound prepared by the action of hydrogen peroxide on 5-hydromethyl-2'-deoxyuridine in acid media. (FR)

2638 γ-IRRADIATION OF THYMIDINE IN AERATED AQUEOUS SOLUTION. II. Characterisation of the Stable Products. Cadet, Jean; Teoule, Robert (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Lab. de Radiobiologie). Bull. Soc. Chim. Fr.; No. 3, 885-890(Mar 1975). (In French).

The principal stable products of γ-irradiation of thymidine in aerated aqueous solution were isolated and identified. They are the four cis and trans diastereoisomers of 5,6-dihydroxy-5,6-dihydrothymidine 2,3 and derivatives formed from the cleavage and the rearrangement of the pyrimidine ring. N-(2-deoxy-β-D-erythro-pentofuranosyl-formamide 5 and the 5S* and 5R* isomers of 1-(2-deoxy-β-D-erythro-pentofuranosyl)-5-hydroxy-5-methyl-hydrantoin 6,5-hydroxymethyl-2'-deoxyuridine 7 and 5-formyl-2'-deoxyuridine 8 are also found in the irradiated mixture. These nucleosides were characterized by spectroscopic methods and prepared by independent synthesis. The products resulting from cleavage of the N-glycosidic bond were identified as γ-irradiation derivatives of thymine and of γ-deoxyribonolactone. (FR)

2639 γ-IRRADIATION OF THYMIDINE IN AERATED AQUEOUS SOLUTION. III. Mechanism and Quantitative Results. Cadet, Jean; Teoule, Robert (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Lab. de Radiobiologie). Bull. Soc. Chim. Fr.; No. 3, 891-895(Mar 1975). (In French).

Quantitative results of the γ-irradiation of 10^{-2} M thymidine [G(-) = 1.92] in aerated aqueous solution were examined. The principal products formed with irradiation doses of between 200 and 4.5×10^3 rads are given in descending quantitative order: pyruvamide [G = 0.490], the four diasteresisomeric 5,6-dihydroxy-

5,6-dihydrithymidines [G = 0.476], N-12-deoxy-β-D-erythro-pentofuranosyl]-formamide [G = 0.380] and the eight isomers of 5-(6)-hydroperoxy-6(or 5)-hydroxy-5,6-dihydrothymidine [G = 0.222]. The formation of the 5-hydroxy-6-hydroperoxy-derivatives is favored in neutral medium whereas for a pH of less than 1.5 the 6-hydroxy-5-hydroperoxy isomers are favored 20% of the degradation processes involve cleavage of the N-glycosidic bond [Gγ-deoxyribonolactone = 0.120]. The behavior of the major radiolysis products (hydro-hydroperoxides, 5,6-thymidinediols, ureides) under irradiation was studied. A reaction scheme for the evolution under irradiation of thymidine in aqueous solution is tentatively proposed and discussed in the light of recent EPR and pulsed radiolysis results. (FR)

2640 CHERENKOV LIGHT SELF-ABSORPTION AS THE INDICATOR OF INTERMEDIATE CHANGES DURING MICRO-SECOND PULSE RADIOLYSIS. Zagorski, Z. P.; Zimek, Z. (Inst. of Nuclear Research, Warsaw). Int. J. Radiat. Phys. Chem.; 7: No. 4, 529-539(Aug 1975).

Measurement of the kinetics of intermediates formed during the pulse of electrons is discussed, using Cherenkov emission as monitoring light for fast spectrophotometric analysis. The emission, diminished by self-absorption due to intermediate products, is derived as a function of optical density for the simplest kinetics — zero-order build-up during the pulse. Tests for deviation from zero order are developed. (auth)

2641 EPR STUDY OF NEUTRON-IRRADIATED CaO: OBSERVATION OF THE MOLECULAR ION OH^{2-}. McGeehin, P.; Henderson, B.; Boas, J. F.; Hall, T. P. P. (Univ. of Keele, Eng.). J. Phys., C (London); 8: No. 11, 1718-1730(7 Jun 1975).

Two previously unreported EPR spectra were observed from defects in neutron-irradiated CaO. The first spectrum consists of a single isotropic line with no apparent structure at g = 2.0051. The second spectrum is described using spin Hamiltonians with S = ½ and I = ½. At room temperature the spin Hamiltonian has axial symmetry, but at 77°K it is orthorhombic. By considering the behavior of the spectrum at intermediate temperatures, it is shown that the higher-temperature spectrum is due to a defect which is moving in the lattice, thereby averaging an otherwise orthorhombic Hamiltonian. The activation energy for this reorientation is found to be ~ 0.13 eV. A detailed model is presented to explain the observed spectra, involving the molecular ion OH^{2-} at an anion site. (auth)

2642 ELECTRON SPIN ECHO ENVELOPE MODULATION OF TRAPPED RADICALS IN DISORDERED GLASSY SYSTEMS: APPLICATION TO THE MOLECULAR STRUCTURE AROUND EXCESS ELECTRONS IN γ-IRRADIATED 10*M* SODIUM HYDROXIDE ALKALINE ICE GLASS. Narayana, P.A.; Bowman, M.K.; Kevan, L. (Department of Chemistry, Wayne State University, Detroit, Michigan 48202); Yudanov, V.F.; Tsvetkov, Yu.D. J. Chem. Phys. 63: No. 8, 3365-3371 (15 Oct 1975).

Electron spin echo signals associated with trapped electrons in aqueous matrices show a modulation due to hyperfine interaction with the surrounding magnetic nuclei. The three pulse electron spin echo modulation gives information about the next nearest neighbor deuterons surrounding the electron. Analysis of the phase change in the three pulse modulation gives an effective deuteron interaction distance of 3.6 Å. The two pulse spin echo modulation depends on both the nearest and next nearest neighbor deuterons. Simulations of this modulation support a structural model in which the number of equivalent nearest neighbor deuterons to the electron is 6 at a distance of 2.1 Å and with an isotropic coupling constant of 0.9 MHz (5.8 MHz for protons). The orientation of the water molecules in the first solvation shell is not uniquely determined and two possible models are proposed. In model I there are three first solvation shell water molecules with their molecular dipoles oriented toward the electron so that there are two nearest neighbor deuterons from each molecule. In model II there are six first solvation shell water molecules with one OD bond oriented toward the electron. Model I is approximately consistent with the semicontinuum model for solvated electrons although the experimental distances are 0.2-0.3 Å larger than the predicted point dipole distances. (auth)

2643 ION MOBILITY MEASUREMENTS IN DIELECTRIC LIQUIDS. Winokur, P.S. (Harry Diamond Laboratories, Adelphi, Maryland 20783); Roush, M.L.; Silverman, J. J. Chem. Phys. 63: No. 8, 3478-3489 (15 Oct 1975).

Ion mobility measurements were made on *n*-hexane and a 0.22*M* solution of biphenyl in *n*-hexane using a time-of-flight technique. A collimated beam of x rays from a flash x-ray generator was used to produce a layer of ions near one electrode of a parallel-plate conductivity cell. Part of the charge layer was swept under the influence of an electric field to the opposite electrode, and the motion of the charge was observed by means of a current-versus-time measurement. Mobilities have been determined by fitting theoretical current–time curves to experimental ones. The theoretical current–time curves were obtained by solving numerically the differential equations governing carrier motion during a mobility measurement. Diffusion, bimolecular recombination, motion under an applied electric field, and induced bulk liquid motion were included in the theoretical model. The measured spatial dose distribution, radiation yield data, applied voltage, and electrode separation were input constants to the theoretical calculation, while values for the anion mobility, cation mobility, and induced liquid acceleration were variable parameters. The theoretical model yields the spatial distribution of charge carriers and its time dependence during the charge transport. It also describes the electric field between the electrodes as a function of space and time and demonstrates the effects of space charge. The current–time curves generated from the model are in good agreement with those obtained experimentally. The theoretical model that includes the effects of induced bulk liquid motion yields values of mobility that are significantly lower than those determined experimentally by use of inflection or "half-steady-state" points. Measurements made on purified *n*-hexane showed that a radiation pulse produces more than one slow carrier of each sign. When biphenyl was added to the sample, one negative and two positive species were observed. Our theoretical fits to experimental curves obtained from the irradiation of a 0.22*M* solution of biphenyl in *n*-hexane yields a mobility value for the negative species of 3.6×10^{-4} $cm^2\,V^{-1}\,sec^{-1}$. This negative species is believed to be the biphenylide anion. (auth)

2644 DEPENDENCE OF FREE ION YIELD ON ELECTRICAL FIELD STRENGTH IN A DIELECTRIC LIQUID IRRADIATED BY ^{60}Co γ RAYS. Casanovas, J.; Grob, R.; Blanc, D.; Brunet, G.; Mathieu, J. (Centre de Physique Atomique, Université Paul Sabatier, Toulouse, France). J. Chem. Phys. 63: No. 8, 3673-3675 (15 Oct 1975).

A corrected curve of free ion yield versus electric field is given for *n*-hexane as well as new curves for 2-methylpentane, 2,2,4-trimethylpentane, and carbon tetrachloride. Comparison with the Onsager theory of geminate ion recombination does not give reasonable agreement over the entire range of field strengths for any of the functions used.(AIP)

2645 LIGHT-INDUCED FLUORESCENCE OF SHORT-LIVED SPECIES PRODUCED BY A PULSE OF RADIATION: THE BENZOPHENONE KETYL RADICAL. Hodgson, B.W.; Keene, J.P.; Land, E.J.; Swallow, A.J. (Paterson Laboratories, Christie Hospital and Holt Radium Institute, Manchester M2O 9BX, England). J. Chem. Phys. 63: No. 8, 3671-3672 (15 Oct 1975).

The optical absorption spectra, kinetic behavior and other properties of numerous short-lived species have been studied by flash photolysis and pulse radiolysis. By a simple modification of the technique we have now been able to measure the emission produced when a short-lived species, in this case the benzophenone ketyl radical, is itself excited by absorption of light, a property which is normally observable only when transient species are stabilized in a rigid medium. (AIP)

2646 EFFECT OF TEMPERATURE ON THE YIELD OF SOLVATED ELECTRONS IN LIQUID ETHANOL. Dixon, R.S.; Lopata, V.J. (Atomic Energy of Canada Limited, Whiteshell Nuclear Research Establishment, Pinawa, Manitoba R0E 1L0, Canada). J. Chem. Phys. 63: No. 8, 3679-3680 (15 Oct 1975).

The decay of the solvated electron and the relative yields of free and geminate solvated electrons have been measured in ethanol in the range 150–290 °K. The estimated absolute yields at low temperature agree well with sub-nanosecond values at room temperature, however the yield of solvated electrons appears to be substantially less than the total ionization yield. (AIP)

2647 SEPARATION OF ISOTROPIC AND ANISOTROPIC HYPERFINE CONSTANTS IN DISORDERED SYSTEMS BY ANALYSIS OF ELECTRON PARAMAGNETIC RESONANCE LINES AT TWO DIFFERENT MICROWAVE FREQUENCIES: APPLICATION TO THE MOLECULAR STRUCTURE AROUND EXCESS ELECTRONS IN γ-IRRADIATED 10*M* SODIUM HYDROXIDE ALKALINE ICE GLASS. Bales, B.L. (Centro de Fisica, I.V.I.C., Caracas, Venezuela); Bowman, M.K.; Kevan, L.; Schwartz, R.N. J. Chem. Phys. 63: No. 7, 3008-3014 (1 Oct 1975).

It is shown that the second moment of an unresolved electron paramagnetic resonance line in disordered systems can lead to separation of the isotropic and anisotropic hyperfine couplings if the spectrum is recorded at high enough microwave frequency to separate the main line from nuclear spin flip satellite lines. If resolution of main and satellite lines is not complete, separate determination of the isotropic and anisotropic couplings is still possible if measurement can be made at two different microwave frequencies of which one frequency is high enough to partially resolve the main and satellite lines. This analysis is applied to excess electrons trapped in 10*M* NaOH alkaline ice glass at 77 K and the isotropic and anisotropic coupling constants are determined as a function of *n*, the number of equivalent nearest neighbor protons. From electron spin echo modulation patterns and the intensity and separation of satellite lines from the main line, the best value of *n* is determined to be 6. The value *n*=6 corresponds to a

trapped electron surrounded by three water molecules with their molecular dipoles oriented toward the electron (2 protons per water molecule) or six water molecules with one OH bond oriented toward the electron. In both cases the protons are 2.1 Å from the electron with an isotropic coupling constant of ~1–2 G. This agrees with independent measurements from analysis of electron spin echo modulation patterns. (auth)

2648 EFFECT OF POLYETHYLENE CRYSTALLIZATION ON THE YIELD OF RADIATION-GRAFTED COPOLYMER. Mironov, N. A.; Kocherginskaya, L. L.; Nikol'skii, V. G.; Rozenblum, N. D. Plast. Massy; No. 1, 19-21(1975). (In Russian)

The effect of the rate of cooling of polyethylene melt on the concentration of captured radicals in an irradiated polymer and on the radiation-grafted copolymer has been studied. It has been shown that a decrease in the cooling rate leads to a significant increase in the yield of grafted product. (JPRS)

2649 FORMATION OF LONG-LIVED HIGHLY-EXCITED STATES OF H, C, AND N ATOMS BY LOW-ENERGY ELECTRON IMPACT ON CH_3CN. Shibata, T.; Fukuyama, T.; Kuchitsu, K. (Tokyo Univ. (Japan). Faculty of Science). Bull. Chem. Soc. Jpn.; 47: No. 10, 2573-2575(Oct 1974).

Long-lived excited states of hydrogen, carbon and nitrogen atoms (H^{**}, C^{**} and N^{**}) produced by the electron bombardment of CH_3CN in the energy range from 20 to 100 eV were detected as H^+, C^+ and N^+ ions as a result of collisions with H_2O. The appearance potential of H^+ was observed to be about 3 eV lower than the threshold energy for He^+ formed from He^* with H_2O (about 24.6 eV). The C^+ threshold energy was about the same as that for He^+, while that for N^+ appeared to be a few eV higher. This suggests that the H^{**} species is mainly responsible for the formation of CH_3CN^- due to the electron bombardment of CH_3CN observed by Sugiura and Arakawa, at least in the energy region below the He^{**} threshold energy. (auth)

2650 SOLVENT EFFECT ON GRAFT COPOLYMERIZATION OF ACROLEIN TO POLYSTYRENE BY IRRADIATION. Miyauchi, S. (Niigata Univ., Nagaoka (Japan). Faculty of Engineering); Ohnishi, S. Kobunshi Ronbunshu; 31: No. 11, 659-664(Nov 1974). (In Japanese)

Graft copolymerization of acrolein to polystyrene film by γ-rays in methanol, ethanol, methanol–carbon tetrachloride and ethanol–carbon tetrachloride is studied. The amount of grafted acrolein in methanol is nearly equal to that in ethanol, but grafted copolymer chain in the former is partly acetalized. The graft copolymerization in methanol–carbon tetrachloride mixture depends on the fraction of carbon tetrachloride, and hardly occurs in the high concentration. It is considered that acetalization of acrolein in the presence of carbon tetrachloride and methanol occurs predominantly over graft copolymerization of acrolein to polystyrene by irradiation. When hydrochloric acid instead of carbon tetrachloride is added in methanol or ethanol and is held for the prolonged time before irradiation, grafting both in methanol and ethanol hardly takes place. However, benzene as a swelling agent being added in the above reaction solution, graftings both in methanol and ethanol take place, and the amount of grafting increases with the amount of benzene. (auth)

2651 ELECTRON SPIN RESONANCE OF RADIATION DAMAGE CENTERS IN $NH_4H_2PO_4$ SINGLE CRYSTAL DOPED WITH K_2SeO_4. Kawano, T. (Kagoshima Univ. (Japan). Dept. of Physics). J. Phys. Soc. Jpn.; 37: No. 3, 848-855(Sep 1974).

Radiation damage centers in $ADP(NH_4H_2PO_4):K_2SeO_4$ mixed crystal were studied with ESR in the temperature range from 90 to 350°K. There are SeO_3^{3-}, SeO_4^-, and SeO_3^- radicals in the crystal, and SeO_4 tetrahedral unit takes substitutionally the position of PO_4 unit. The ESR spectrum of SeO_3^{3-} radical has well-resolved proton superhyperfine structure, which shows the "quintet to triplet" transition, and exhibits domain splitting in low temperature range as seen on AsO_4^{4-} radical in $KDA(KH_2AsO_4)$. Using the temperature dependence of the domain splitting and line widths, the correlation time for the motion of Se^{77} nucleus was estimated. The temperature dependence of correlation times is well fitted to the Arrhenius law: $\tau_C = \tau_{CO} \cdot \exp(E_\alpha/kT)$ with $E_\alpha = 0.19$ eV for $ADP:K_2SeO_4$ and $E_\alpha = 0.11$ eV for $KDP:K_2SeO_4$. (auth)

2652 PREPARATION OF A NEW TYPE OF SYNTHETIC FIBER FROM LINEAR POLYETHYLENE BY IRRADIATION CROSS-LINKING. Kitamaru, R.; Tsuchiya, C.; Hyon, S.-H. (Kyoto Univ., Uji (Japan). Inst. for Chemical Research). Bull. Inst. Chem. Res., Kyoto Univ.; 52: No. 2, 436-441(Sep 1974).

A lightly cross-linked polyethylene filament was obtained by a conventional melt-spinning and an irradiation with an electron beam from Van de Graaff. This cross-linked filament was stretched to a high extent in the perfectly molten state at high temperatures above its melting temperature and quenched. Through these procedures a new type of synthetic fiber having high melting temperatures as well as excellent mechanical and fiber properties was prepared. The fiber obtained did not shrink appreciably if boiled in water for more than two hours and held its fiber properties. (auth)

2653 STUDY OF TEXTURES OF THE GAMMA-RAY-INDUCED POLYETHYLENE BY OZONE DEGRADATION. Arai, Hidehiko; Senrui, S.; Nakase, Y.; Kuriyama, I. (Japan Atomic Energy Research Inst., Takasaki, Gunma. Takasaki Radiation Chemistry Research Establishment). Rep. Prog. Polym. Phys. Jpn.; 17: 265-268(Jul 1974).

Polyethylene was prepared by the gamma-induced polymerization of ethylene at 30 and 90°C. The ozone degradation of powdery polyethylene was performed by exposing the powder to ozone-containing oxygen for a given time at room temperature. The weight increase of samples was expressed as the percentage of the initial weight of polyethylene. Thermal measurement was performed with a Perkin–Elmer DSC apparatus at the heating rate of 8°C/min. The chromatogram maximum split into 2 peaks at the lower molecular weight end of distribution after 6 hours of degradation. When the weight increase with ozone degradation reached the limiting value, the chromatograms showed 2 distinct peaks, and the peak at the largest elution value became sharp, and its position was limited at a constant elution volume. The molecular weight at the peak in the chromatograms corresponded to single chain traverse through the crystalline core of layer. The limiting values of molecular weight for the gamma-induced polyethylene formed at 30 and 90°C and Sholex 6050 are about 1000, 1850, and 2000, respectively. The gamma-induced polyethylene at 30°C was composed of small lamellar crystals with irregular structure of basal surface such as loose loop and tie molecules, while that formed at 90°C was composed of relatively large lamellar crystals with irregular growing faces due to many methyl branches. (JA)

2654 VISCOELASTIC BEHAVIOR OF GAMMA-IRRADIATED POLYTETRAFLUOROETHYLENE BY TBA METHOD. Takenaga, M.; Obori, H.; Yamagata, K. (Science Univ. of Tokyo (Japan). Faculty of Science). Rep. Prog. Polym. Phys. Jpn.; 17: 349-352 (Jul 1974).

TBA measurement was made in the range of 25–360°C. Relative rigidity and logarithmic decrement were measured in relation to temperature for 2 composites of irradiated samples, with the total doses of 1×10^8R and 1.8×10^9R. The measurement for unirradiated PTFE was made by torsional pendulum method. The logarithmic decrement near the melting temperature of unirradiated sample showed a peak with the temperature width of about 10°C at the baseline, in which the maximum value was about 327°C. The tendency of the relative rigidity was apparently similar to that of the samples irradiated by 10^8R, and the minimum value at high temperature was about 327°C. The value of 327°C was in good agreement with that of the melting temperature of PTFE. In case of 1×10^8R samples, at the melting temperature in the vicinity of 320°C, the abrupt decrease in relative rigidity and a peak in logarithmic decrement occurred. The slope of the decrease in rigidity near 320°C was the steepest among 3 specimens. The lowering of the melting temperature of samples of 10^8R by 7°C from that of unirradiated PTFE was attributable to the decrease in molecular weight due to the scission of main chain. For the specimens irradiated by 1.8×10^9R, the relative rigidity decreased slowly up to about 290°C, then did not change with temperature. (JA)

2655 PHYSICAL STATE OF RADIATION-INDUCED POLYMERIZED POLYETHYLENE BLENDS. Yamaguchi, K.; Yagi, T.; Machi, S.; Takehisa, M. (Japan Atomic Energy Research Inst., Takasaki, Gunma, Takasaki Radiation Chemistry Research Establishment). Rep. Prog. Polym. Phys. Jpn.; 17: 473-476(Jul 1974).

High-density polyethylene (HDPE, Hizex 1000J of Mitsui Petrochemical Co.) and the radiation-polymerized polyethylene produced by Japan Atomic Energy Research Institute were used as blending materials. Two kinds of polyethylene were blended by melting at 160°C for 30 min and 30 rpm mixing with the Brabender Plasticorder. The sheets of the blends were hot-pressed to 0.5 mm thickness and quenched to room temperature. The haze value was calculated by Haze (%) = $T_d/T_t \times 100$, where T_t and T_d are total and diffuse transmittances measured by an integration sphere haze-meter. A sample cell was filled with dimethyl phthalic acid ($n_d = 1.51$) to prevent scattering on the surface of the specimen. As the total transmittance is approximately the same for all speciments, the haze value represents the diffuse transmittance. Lower haze value is equivalent to higher transparency. The haze value of the blends decreased considerably with increasing radiation-polymerized polyethylene content. That of the blends of high-density polyethylene with low-density polyethylene did not change up to 50 wt% content of low-density polyethylene. As

the total transmittance of the blends was approximately the same in spite of the decrease in haze value, the transparency of both high-density polyethylene and low-density polyethylene was improved by blending with radiation-polymerized polyethylene. The haze value remarkably increased as the temperature of heat treatment increased. (JA)

2656 MOLECULAR MOTIONS IN GAMMA-IRRADIATED POLYTETRAFLUOROETHYLENE. Kadomatsu, Y.; Motohashi, S.; Yamagata, K. (Science Univ. of Tokyo (Japan). Faculty of Science). Rep. Prog. Polym. Phys. Jpn.; 17: 511-514(Jul 1974).

Molecular motion as observed with nuclear magnetic resonance (NMR) in γ-irradiated polytetrafluoroethylene (PTFE) was studied in relation to the band structures observed on fracture surfaces and the lamellar thickness estimated from small angle x-ray diffraction patterns. Electron micrographs of the fracture surfaces of samples were taken with the aid of platinum-carbon replicas, and broad line NMR measurement was carried out on the same samples. The small angle x-ray measurement was made at room temperature with a small amount of the samples investigated with NMR. In case of the samples with total dose of 1.66×10^9 R, the decrease in second moment was observed at approximately –150°C. The change in the second moment became gradual as crystallization time was increased. A narrow component, which was not observed below –150°C, was clearly recognized at –120°C, and the decrease in second moment corresponded to the appearance of the narrow component. Mobile fraction was estimated as 10% from the line shape observed at –120°C. Diffraction patterns became more diffuse with the increase of the time of crystallization. The variation of second moment as a function of temperature suggested the existence of some kind of molecular motion above –120°C. Apparent transition temperature of –45°C was estimated from the experimental results, but the precise mechanisms of the transition are not clear yet. (JA)

2657 RADIATION-INDUCED INCREASE IN CRYSTALLINITY OF POLYTETRAFLUOROETHYLENE. Tutiya, M. (Tokyo Metropolitan Isotope Research Center (Japan)). Rep. Prog. Polym. Phys. Jpn.; 17: 515-518(Jul 1974).

The increase in the crystallinity of PTFE was measured by NMR as a function of total dose, and the mechanisms were discussed. PTFE samples were exposed to ^{60}Co γ-rays at room temperature, in air, at a dose rate of $5.5 \times 10^5 - 9.4 \times 10^5$ R/hr. After irradiation, the samples were annealed at 300°C for 4 hours in air. Then NMR spectra were measured at –9°C, and the degree of crystallinity was calculated from the spectra according to Wilson–Pake's method. Another series of PTFE enclosed in evacuated glass tubes were irradiated with dose rate of $5.5 \times 10^5 - 9.8 \times 10^5$ R/hr, and then annealed at 300°C for 4 hours. The ratio of amorphous fraction to the whole, A/Ao, plotted as a function of total dose for 2 series of PTFE indicated that the fraction decreased with increasing dose. By doubly lograrithmic plotting, the experimental data were approximated by two parallel straight lines. The main difference between the PTFE samples irradiated in air and in evacuated glass tubes was that the amorphous fraction of PTFE decreased at lower dose in the PTFE irradiated in air. This result indicates that the radiation-induced increase in crystallinity is sensitive to the presence of oxygen. The values of α, where $\alpha = rVo/n$, was estimated to be 2.6×10^{-6}/R in air. That in evacuated glass tubes was 3.9×10^{-6}/R. Then the ratio of scission probability, r, in air to that in evacuated glass tubes is estimated to be about 7. That is, the G-value of C-C scission in the case of irradiation in air is about 7 times as large as that in the case of irradiation in evacuated glass tubes. (JA)

2658 COMPOSITIONS FOR METALS COATINGS. Murakami, S.; Chihara, Y. (to Nippon Oils and Fats Co. Ltd., Tokyo). Japanese Patent 1974-8923/B/. 1 Oct 1968. 4p. (In Japanese)

A composition which can be hardened by radiation polymerization is provided, comprising a reaction product and an inorganic acid. The reaction product is produced by reacting at least one compound containing at least one epoxy radical in its molecule with at least one compound selected from the group of unsaturated carbonic acids and unsaturated carbonic acid amino esters. The inorganic acid may be phosphoric acid and chromic acid. Addition of phosphoric acid and/or chromic acid to this composition increases adhesiveness and corrosion resistance. This composition forms a high molecular network by short-term irradiation, so that application time can be reduced. It easily forms a thick coating layer since no solvent is required, it has better corrosion resistance due to network construction, and it is stable because of the reaction between phosphoric acid and the relatively low molecular weight epoxy radicals. The amount of added phosphoric acid and/or chromic acid is 0.1 to 20% of the composition, depending on compositions and use. The composition may be blended by vinyl butyral resin, acrylic resin, vinyl chloride resin, chlorinated polypropyrene resin, aklyd resin, phenolic resin, melamine resin and the like. This composition can be applied to surfaces such as zinc, tin, aluminum and their alloys, as well as iron and steel. (JA)

2659 METHOD OF MAKING A COATED STEEL PLATE. Yoshida, K.; Hamamura, T.; Kanamaru, T. (to Nippon Steel Corp., Tokyo). Japanese Patent 1974-8929/B/. 6 Aug 1969. 6p. (In Japanese)

A method of applying a protective coating to a layer of an electron-sensitive primer coated onto a surface-treated steel plate is given, using a composition that can be hardened by irradiation with electron beams. In one embodiment, an acrylic coating is applied as a primer 5μ thick to a steel plate, and then baked at 500°C for 4 to 8 seconds. After 8 seconds, the primer is completely baked onto the plate. When the primer is lightly baked and is hardened by irradiation together with the superimposed layer, the coatings show superior adhesiveness and bending strength. The superimposed layer has a composition which comprises, for example, a polymer having a double bond and/or epoxy radical, and a monomer having a double bond such as styrene and acrylic acid. The thickness of the superimposed layer may preferably be 5-50μ for adhesive and corrosive properties. The energy level of electron beams may be 100-500 KeV. The radiation doses may be 0.1-10, preferably 0.5-5 Mrad. In one example, an acrylic thermosetting electron-sensitive coating as a primer was electrodeposited onto a galvanized sheet treated by chromate. The thickness of the primer was 2μ. The electrodeposited sheet was baked at 280°C for 30 seconds. Thereafter, a mixture of acrylic polymer with acrylic monomer was applied to the primer with a 7μ roll-coater, and was hardened by electron beams with 25 Mrad at a line speed of 60 m/min. A satisfactory product was obtained. (JA)

2660 METHOD OF RADIATION POLYMERIZATION. Kagiya, T.; Mitsui, H.; Tsuneta, K.; Hosoi, F.; Fujimoto, T. (to Japan Atomic Energy Research Inst., Tokyo). Japanese Patent 1974-11271/B/. 8 May 1970. 3p. (In Japanese)

Methyl methacrylates can be cross-linked by irradiating with beams of radiation in the presence of triple bond-containing acetylene carboxylic acids. The triple bond at the distal end of the carboxylic acids promotes polymerization, thereby accelerating cross-linking. The amount of the acetylene carboxylic acids may be from 5 ppm to 10%, preferably 100 ppm to 1% by weight. In one example, 100 parts of purified methyl methacrylate was mixed with 0.6 part of propionic acid in an ampoule. After the removal of air, the contents were irradiated with gamma-rays from a ^{60}Co source at a dose rate of 3.4×10^4 rad/hr for 6 hours and 16 hours at 30°C. The product polymers were dipped in boiling acetone to measure the degree of polymerization and gel content. The degree of polymerization was 80.5% and 100%, respectively, against a reference value 46.9% and 100%. The gel contents were 3.6% and 96.9% against a reference 0.0% and 0.0%. Experiments revealed that the addition of a small amount of propionic acid increases the velocity of polymerization to form cross-linking. (JA)

2661 COMPOSITION AND METHOD FOR APPLYING A COATING WITH LOW ENERGY ELECTRON BEAMS. Kimura, T.; Kobayashi, J.; Harada, H. (to Mitsubishi Rayon Co. Ltd., Tokyo (Japan)). Japanese Patent 1974-5727/B/. 4 Apr 1968. 7p. (In Japanese)

A method for applying a coating onto plywood surfaces by irradiation with low-energy level electron beams is given using a prepolymer monomer syrup prepared by blending four compositions in the proportion of either (A)/(C) or (A)/(D) = 1/9 to 9/1 and either (B)/(C) or (B)/(D) = 1/9 to 9/1 by wieght. The (A) indicates an acrylic prepolymer having an average molecular weight of 1,000 to 3,000,000 and consisting of either acrylic acid alkyl ester and methacrylic acid alkyl ester, or 0.5% to 50% of a copolymerizable vinyl monomer with 50% to 99.5% of said acrylic acid alkyl ester. The (B) indicates a prepolymer having an average molecular weight of 1,000 to 3,000,000 and a vinyl radical on its side chain. The (C) indicates a monomer mixture consisting of 50-98% by weight of acrylic or methacrylic acid alkyl ester, 1-10% of a monomer containing at least two vinyl radicals and 1-49% of copolymerizable monomers with them. The (D) indicates a monomer consisting of acrylic or methacrylic acid alkyl ester, or consisting of 50-99% of said monomer and 1-50% of copolymerizable vinyl monomer. Such a monomer syrup may contain paraffin wax and mp. 80°C or less, and may contain poly epoxide resins. The thickness of the applied coating is between 5 to 500μ. Under such conditions, printed decorative plywood plates can be produced by irradiation with electron beams at an energy level of 50 to 500 KeV without the need for the conventional two liquid type resin and catalysts. Product properties are excellent. (JA)

2662 COMPOSITION AND METHOD FOR APPLYING A COATING WITH LOW ENERGY ELECTRON BEAMS. Kimura, T.; Kobayashi, J.; Harada, H. (to Mitsubishi Rayon Co. Ltd., Tokyo (Japan)). Japanese Patent 1974-5726/B/. 4 Apr 1968. 6p. (In Japanese)

A method for applying a coating onto plywood surfaces by irradiation with electron beams at a low energy level is given, using a prepolymer monomer syrup consisting of at least two compositions (A) and (B). The composition (A) consists of an unsaturated polyester prepolymer having an average molecular weight between 500 and 50,000, and saturated polybasic acids. The (A) may contain 5-95.01% of unsaturated polybasic acids and higher alcohols. The composition (B) is a monomer mixture and consists of acrylic alkyl esters and/or methacrylic alkyl esters, and may contain 5-99.5 wt% of another copolymerizable monomers. The quantity ratio of (A) : (B) is between 2/8 and 8/2 by weight. The prepolymer monomer syrup in accordance with the second invention contains paraffin wax having a melting point at 80°C or less to prevent vaporization of the monomer. The syrup in accordance with the third invention contains an epoxy resin having an epoxy equivalent of 80 to 2,000 to improve its physical properties. The thickness of the applied coatings ranges between 5-500μ. Under such conditions, the coating can be hardened with electron beams at an energy level between 50 and 500 keV, without the need for the conventional liquid resin and catalysts. The products have a high degree of hardness, excellent resistance to abrasion, and are additionally resistant to water, chemicals and contaminants. (JA)

2663 COATING MATERIAL COMPOSITION. Kimura, T.; Ozeki, T.; Kobayashi, J.; Nakamoto, H.; Maeda, Y. (to Mitsubishi Rayon Co. Ltd., Tokyo (Japan)). Japanese Patent 1974-12088/B/. 6 Nov 1969. 8p. (In Japanese)

A coating material composition can easily be cross-linked by irradiation with activation radiations, using a prepolymer (A) and an aligomer (B). Prepolymer (A) is a modified polymer produced by primarily reacting at least 0.1 mol of saturated cyclic carboxylic anhydride and/or alpha, beta-ethylenic unsaturated carboxylic anhydride with one mole of hydroxyl radical of a basic polymer, and by secondarily reacting at least 0.1 mol of an epoxy-radical containing vinyl monomer with one mol of the total of hydroxyl radical and carboxyl radical of the primary reaction product, wherein the basic polymer consists of 1-40% by weight of hydroxyl-containing monomer, 30-99% of (meth)acrylic monomer and 69% or less of other vinyl monomers. The basic polymer has an average molecular weight of 1,000 to 100,000. Oligomer (B) is an addition reaction product of saturated polycarboxylic acid or its anhydride and an epoxy-containing vinyl monomer. (JA)

2664 PROCESS FOR PREPARING RADIATION-CURABLE ACRYLATES OILS. Wako, Shinichi. (to Nippon Oils and Fats Co. Ltd., Tokyo). Japanese Patent 1974-28894/B/. 2 Dec 1970. 3p. (In Japanese)

A process for preparing a radiation-curable acryl-modified linseed oil usable as a coating material, an adhesive or a wood modifier is provided. The oil is prepared by reacting an epoxidized linseed oil with acrylic or methacrylic acid to give a hydroxy-acrylated oil (oxirane content 8.5 ± 0.5%, acryl content 3.5 to 4.0 moles per one mol of the oil). It cures upon irradiation with electron beams or gamma rays (15 to 21 Mrad) to give an inexpensive and yellowing-free coating of excellent hardness and chemical resistance. In one example, 51.6g of an epoxidized linseed oil (prepared according to USP 3242196, MW 964, oxirane content 9.1%) was reacted with 29.8g of acrylic acid at 137°C for various time periods. The products were applied to tin-plated steel and exposed to gamma-rays (5500 r/min) in a N_2 atmosphere. Maximum hardness was attained when the total radiation dose reached about 20 Mrad. Acryl content of the oil and maximum hardness after cure were: 2.5, 16; 3.5, 28; 3.9, 38. (JA)

2665 METHOD FOR PREPARING COATING FILMS. Arakawa, K.; Mori, T. (to Matsushita Electric Industrial Co. Ltd., Kadoma, Osaka (Japan)). Japanese Patent 1974-31740/B/. 22 Aug 1968. 2p. (In Japanese)

A method of preparing a radiation-cured coating film free from gas bubbles is provided. The method comprises preliminarily applying the substrate with a reactive diluent followed by coating with solvent-free conventional radiation-curable coating resins, and finally curing with radiation. Since the resin contains no diluent, the curing process is not thereby retarded. In one example, wood was applied with styrene monomer as a reactive dilutent followed by a polyester resin (50 cp), and then irradiated with electron beams (8×10^6 rad). No bubbles were observed in the cured film. (JA)

2666 SPATIAL DISTRIBUTION OF ELECTRONS AND THEIR REACTIVITY IN LIQUID 2-METHYLTETRAHYDROFURAN. Teply, J.; Janovsky, I. (Inst. of Nuclear Research, Rez, Czech.). Radiochem. Radioanal. Lett.; 22: No. 5, 299-306(24 Sep 1975).

The electron yields and rate constants of electron reactions with several solutes in liquid 2-methyltetrahydrofuran were determined. The results are compared with values obtained in other media. The question of the spatial distribution of electrons and the factors influencing their chemical reactivity are discussed. (auth)

2667 RADIOLYSIS OF IODINE IN DEAERATED BORATE SOLUTIONS AT pH 7 TO 9. Habersbergerova, A.; Bartonicek, B. (Inst. of Nuclear Research, Rez, Czech.). Radiochem. Radioanal. Lett.; 22: No. 5, 307-312(24 Sep 1975).

The chemical changes of iodine dissolved in deaerated aqueous borate solutions irradiated with gamma or mixed reactor radiation in the pH range 7-9 were investigated. It was found that with increasing pH the yields $G(-I_2)$ and $G(I^-)$ decrease while $G(-IO_3^-)$ increases. The dominant factor is the ratio of concentrations $[I_2]/[IO_3^-]$ in the solution before irradiation. (auth)

2668 FREE RADICALS IN AN ADAMANTANE MATRIX. XI. Electron Paramagnetic Resonance Study of Conformations in the beta-halo-tert-butyl Radicals. Lloyd, R. V.; Wood, D. E. (Univ. of Connecticut, Storrs). J. Am. Chem. Soc.; 97: No. 21, 5986-5992(15 Oct 1975).

The beta-halo-tert-butyl radicals were prepared by x-irradiation of the corresponding isobutyl halides in an adamantane matrix at 77°K and their conformations were determined by analysis of their EPR spectra. It was concluded that the radicals are nonplanar at the radical site, the fluoro and chloro radicals trans eclipsed and the bromo and iodo radicals gauche staggered with respect to the relative orientation of the carbon halogen bond and the direction of the singly occupied orbital. Vibration-rotation motions about the favored conformation are much larger for the fluoro radical than for the others. The rate of interconversion of the inequivalent methylene protons is approximately 1.5×10^9 sec^{-1} for the bromo radical at 202°K while it is too slow to measure for the iodo radical at the same temperature. The barrier to interconversion has a lower limit of 3 kcal/mol for the bromo radical and higher than that for the iodo radical. The halogen and proton hfsc in gauss and the g values for the $XCH_2C(CH_3)_2$ radicals are: ^{19}F equals 103.7, CH_2 equals 10.4, CH_3 equals 23.3, g equals 2.0030 at 214 K; ^{35}Cl equals 19.5, CH_2 equals 6.3, CH_3 equals 21.1, g equals 2.0042 at 215 K; ^{81}Br equals 6.7, CH_2 equals 21.4, 42.7, CH_3 equals 21.4, g equals 2.0010 at 202 K; ^{127}I equals 7.0, CH_2 equals 21.9, 43.8, CH_3 equals 21.9, g equals 2.0009 at 208 K. The fluoro radical decays to nonradical products above 318°K, the chloro radical converts to 2-methyl allyl radical above 306°K, the bromo radical converts to tert-butyl radical by exchange with a matrix proton (or deuteron) at 209°K as does the iodo radical above 225°K. Photolysis with a Xe lamp converts the bromo and iodo radicals to nonradical products in less than the experimental time constant of 0.3 sec, whereas the other radicals are essentially unaffected. The hypothesis is put forward that the nonplanarity and high barrier to rotation observed explain the retention of stereochemical configuration in reactions involving beta-chloro, beta-bromo, and beta-iodo alkyl radicals. (auth)

2669 LIFETIMES FOR OH AND OD ELECTRONIC STATES WITH RESONANCE TRANSITIONS IN THE REGION BETWEEN 1700 AND 1950 Å. Smith, Wm.H.; Stella, G. (Princeton University Observatory, Princeton, New Jersey 08540). J. Chem. Phys. 63: No. 6, 2395-2397 (15 Sept 1975).

The upper states of the OH and OD bands in the 1700–1950 Å region have been studied with our phase-shift radiative lifetime apparatus. We have found lifetimes varying from 1.8±0.2 to 2.9±0.4 ns. Lifetimes for OH and OD are essentially the same, indicating that the upper states are likely to be depopulated via purely radiative processes under our experimental conditions. Lifetimes have also been obtained for the $C\,^2\Sigma^+$–$A\,^2\Sigma^+$ transition in OH and OD. Our results are consistent with the preliminary analysis of Pryce (private communication) that the 1700–1950 Å bands in OH are partly due to the $C\,^2\Sigma^+$–$X\,^2\Pi_i$ transition. (auth)

2670 AN ESR STUDY OF $[V(CN)_5NO]^{4-}$ IN γ-IRRADIATED $K_3V(CN)_5NO{\cdot}2H_2O$. Manoharan, P.T.; Vijaya, S. (Structural Chemistry Group, Indian Institute of Technology, Madras 600036, India); Shock, J.R.; Rogers, M.T. J. Chem. Phys. 63: No. 6, 2507-2510 (15 Sept 1975).

An ESR study of electron damaged $K_3V(CN)_5NO{\cdot}2H_2O$ shows the presence of a d^3 species $V(CN)_5NO^{4-}$ with the spin Hamiltonian parameters $g_\parallel = 1.974$, $g_\perp = 2.0007$, A (^{51}V) = -116.03×10^{-4} cm^{-1}, B (^{51}V) = -43.76×10^{-4} cm^{-1}, A (^{14}N) = -1.8×10^{-4} cm^{-1}, and B (^{14}N) = -6.42×10^{-4} cm^{-1}. Results of a simplified semiempirical molecular orbital approach have been used to correlate the experimental spin Hamiltonian parameters of the isoelectronic d^3 series from vanadium to iron. In addition, the ligand hyperfine splittings due to ^{14}N have been explained on the basis of a configuration interaction mechanism. (auth)

2671 PHOTOSTIMULATED REACTIONS OF ISOLATED AND PAIRED RADICALS IN SOLID HYDROCARBONS. Sprague, E.D.; Willard, J.E. (Department of Chemistry, University of Wisconsin, Madison, Wisconsin 53706). J. Chem. Phys. 63: No. 6, 2603-2608 (15 Sept 1975).

Ultraviolet radiation absorbed by radicals trapped in γ-irradiated 3-methylpentane (3MP), 3-ethylpentane (3EP), and 3-methylheptane (3MHp) glasses and in polycrystalline *n*-hexane at 77 K causes a major improvement in resolution of the ESR spectra without change in the radical concentration, indicating that the energy of the absorbed photons changes the nature, the configuration, or the environment of the radicals. The new spectral shape slowly reverts to the old in the dark at a rate which is dependent on the matrix and the temperature. Ultraviolet irradiation also accelerates the decay of paired radicals and other radicals which are removed by intraspur processes, but not of those which react by random encounter after diffusion. This effect is attributed to localized heating of the matrix in the immediate vicinity of a radical which has absorbed a photon. Secondary 3-ethylpentyl radicals in glassy 3EP undergo spontaneous conversion to an isomer or change to a new rotamer configuration in the dark and the process is reversed by exposure to uv light. The $\Delta M_s=2$ ESR spectrum of radical pairs in γ-irradiated 3MHp has been observed. (auth)

2672 ON ELECTRON MOBILITY MODELS FOR LIQUID HYDROCARBONS. Dodelet, J.; Shinsaka, K.; Freeman, G.R. (Chemistry Department, University of Alberta, Edmonton, Canada T6G 2E1). J. Chem. Phys. 63: No. 6, 2765-2766 (15 Sept 1975).

The electron mobility and activation energy of some liquid hydrocarbons have been measured and compared to theoretical values. The results indicate that an intermediate theoretical model is necessary. (AIP)

2673 RADIOLUMINESCENCE OF H_2O AND D_2O ICE. Steen, H.B.; Holteng, J.A. (Biophysics Department, Norsk Hydro's Institute for Cancer Research, Montebello, Oslo 3, Norway). J. Chem. Phys. 63: No. 6, 2690-2697 (15 Sept 1975).

The luminescence emitted during x-ray irradiation of H_2O and D_2O ice at 77 K exhibits an identical emission band peaked at 373 nm. D_2O also exhibits a band peaked at 534 nm which is not seen for H_2O. The 373 nm band appears to have a decay time in the range 10^{-4}–10^{-3} sec, whereas the 534 nm band decays completely in less than 10^{-4} sec. The emission yield is $G\sim2\times10^{-2}$ and $G\sim2\times10^{-3}$ for D_2O and H_2O, respectively. The yield of the peak at 373 nm is significantly increased by NaCl, NaBr, NaI, and HCl in concentrations above $10^{-3}M$, whereas the 534 nm band in D_2O is not affected by any of these additives. $AgNO_3$, H_2O_2, and $NaNO_3$ reduce the emission yield whereas other efficient electron and OH scavengers like CCl_3COONa and acrylamide do not affect the luminescence even in concentrations of $1M$. The identity of the luminescent species is obscure. The scavenger effects indicate that it has a mobile precursor which is not electrons or OH and probably not H atoms. The emission yields, as well as the decay time of the 373 nm band, decrease with increasing temperature. The 373 nm band is more sensitive to heating than the 534 nm band. In mixtures of D_2O and H_2O the emission yields fall off more rapidly with increasing H_2O concentration than expected if the emissions from D_2O and H_2O were additive. This effect is consistent with the assumption that the differences between H_2O and D_2O are largely due to quenching processes that are more efficient in H_2O. (auth)

Radiochemistry and Nuclear Chemistry

Refer also to abstract 4289.

2674 RADIOACTIVITY AND ATOMIC THEORY. Trenn, T. J. (ed.). New York; John Wiley and Sons, Inc. (1975). 528p. $35.00.

The book comprises 12 chapters: general; disintegration theory; uranium, actinium, and thorium series; genetic series beyond emanation; radioactive radiations; secondary effects and processes of radiations; spectroscopic aspects; atomic theory; electrical aspects; chemical aspects; isotopes and the Periodic Table; and terrestrial and cosmological aspects. Facsimile reproductions of Soddy's reports on radioactivity are included. (LK)

Hot-Atom Chemistry

2675 (ORO-3898-27) HOT ATOM REACTIONS INVOLVING MULTIVALENT AND UNIVALENT SPECIES. Progress Report, February 1975–January 1976. Tang, Y. N. (Texas Agricultural and Mechanical Univ., College Station (USA). Research Foundation). 1975. Contract AT(40-1)-3898. 14p. Dep. NTIS $4.50.

Progress has been made during this period in the study of three kinds of multivalent hot atoms formed by the nuclear recoil method: ^{31}Si, ^{32}P, and ^{11}C. For ^{31}Si recoil reactions, effects of additives on the reactions of monomeric $^{31}SiF_2$ with 1,3-butadiene were studied. It was concluded that recoil ^{31}Si reactions with PF_3 resulted in the formation of both singlet and triplet $^{31}SiF_2$ in the ratio of 1.0 : 3.3. For recoil ^{32}P reactions, a moderator study was made on the effect of He, Ne, and Ar on the ^{32}P abstraction reactions. The reaction probability curve for the H-abstraction from PH_3 to give $^{32}PH_3$ covers an extremely wide range but has a threshold somewhat above the thermal energy range, while the reaction probability curve for the F-abstraction from PF_3 to give $^{32}PF_3$ is narrow but has a threshold in or below the thermal energy range. Mechanistic studies were made for ^{32}P abstraction reactions with a PF_3/PCl_3 mixture. Both a single-step simultaneous abstraction and a stepwise abstraction mechanism must be present. The effect of pressure and scavenger concentration on various products observed in the recoil ^{11}C reactions with 1,3-butadiene has been extensively studied. It is also observed that with the addition of an easily abstractable hydrogen source such as SiH_4 to the system, the acetylene-^{11}C yield decreases sharply while products corresponding to $^{11}CH_2$ reactions increase. (auth)

2676 ETHYLENE FORMATION IN CARBON ATOM REACTIONS. Mechanism and Isotope Effects. Taylor, K. K.; Ache, H. J.; Wolf, A. P. (Virginia Polytechnic Inst. and State Univ., Blacksburg, VA). J. Am. Chem. Soc.; 97: No. 21, 5970-5974 (15 Oct 1975).

Energetic carbon-11 atoms were allowed to react with specifically deuterated hydrocarbons containing completely deuterated methyl or methylene groups and with mixtures of protonated and perdeuterated hydrocarbons. The doubly labeled ethylenes (^{11}C and D) formed in this process were radio gas chromatographically analyzed. The failure to observe carbon-11 labeled $C_2H_2D_2$ in any of these systems suggests that a mechanism including C_2 formation, e.g., by "high-energy stripping", and subsequent hydrogen abstraction does not significantly contribute to ethylene-^{11}C production. The ratios $^{11}C_2H_3D/^{11}C_2H_4$ and $^{11}C_2D_4/^{11}C_2HD_3$ obtained from reaction in equimolar mixtures of C_2H_6 and C_2D_6 or C_3H_8 and C_3D_8 and in CH_3CD_3 are consistently greater than 1, which provides additional support for the contention that ethylene-^{11}C is formed primarily via methylene insertion into the carbon-hydrogen bonds of methyl groups. The ^{11}C distribution among the various isotopic ethylenes observed in the systems under investigation indicates preferential CD formation and preferred insertion by methyne (^{11}CD or ^{11}CH) into CH_3 relative to CD_3 groups. (auth)

Properties of Radioactive Materials

Refer also to abstracts 2561, 3379, and 3418.

2677 (CEA-R-4665) CONTRIBUTION TO THE STUDY OF THE OXIDATION REACTION OF PENTAVALENT NEPTUNIUM BY NITRIC ACID CATALYZED BY NITROUS ACID. Moulin, J. P. (CEA Centre d'Etudes Nucleaires de Saclay, 91–Gif-sur-Yvette (France)). Aug 1975. 91p. (In French). Dep. NTIS (US Sales Only) $6.00.

Thesis.

A report is given on a study of the oxidation reaction kinetics from pentavalent neptunium to hexavalent neptunium by nitric acid catalyzed by nitrous acid: $NpO_2^+ + \frac{3}{2} H^+ + \frac{1}{2} NO_3^- \rightleftharpoons NpO_2^{++} + \frac{1}{2}HNO_2 + \frac{1}{2} H_2O$. In the first part, the chemical properties of uranium, neptunium, plutonium, and americium elements are reviewed, and a detailed bibliographical survey on the kinetics of the oxydo-reduction reactions of these elements with nitric and nitrous acids is presented (51 references). Kinetic measurments using solvent extraction are critically reviewed. Emphasis is placed on differences between their application field and validity area as the aqueous phase where the reaction is carried out, is or is not permanently mixed with the organic phase. It was found that only when both phases are mixed up does the extraction of a reaction product (here Np^{VI}) induce an equilibrium displacement. This point allows the study of the kinetics of some reactions in concentration fields of reagents where no other method can be used. Tributyl phosphate was used as solvent; mathematical apparatus for rate calculation are found at the end of the paper. The reaction stoichiometry was checked; the extraction of nitrous acid in the solvent made it possible to keep constant concentrations of nitrous acid in the same order of magnitude as that of neptunium. This is very useful and can be obtained only by the solvent extraction method used. The following rate law is suggested: $(d/dt)\,[Np^V] = k\,[(HNO_2)\cdot(Np^V)/a(HNO_2) + b(Np^V)]$, where a and b are constants and k is a function of temperature and concentrations of the ions of nitric acid. The effects of temperature and nitric acid concentration were studied. For the latter, good agreement was found with previous works. The validity of results and the mechanism are discussed. It is concluded that tetravalent nitrogen must play a major part in the pentavalent neptunium

oxidation. The results enable prediction of the behavior of neptunium in a mixer-settler experiment. Calculated and experimental concentrations are in good agreement. (auth)

2678 (CONF-750410-10) PREPARATION OF ^{80}Br OR ^{82}Br-BIOMOLECULES VIA EXCITATION LABELLING METHODS. Wong, S.; Ache, H. J. (Virginia Polytechnic Inst., Blacksburg (USA). Dept. of Chemistry). 1975. 22p. Dep. NTIS $4.50.

From 169th national meeting, American Chemical Society; Philadelphia, Pennsylvania, USA (6 Apr 1975).

The direct decay-induced ^{82}Br (or ^{80}Br) labelling by exposing the solid substrate molecules, such as deoxyuridine, L-tyrosine, guanosine, deoxycytidine, phenylalanine, and acetic acid, to gaseous $CF_3{}^{82m}Br$ (or $CF_3{}^{80m}Br$) was studied. The radiochemical yields of the brominated products are relatively small and range from 1 percent in the case of bromo deoxyuridine to 11 percent for bromoacetic acid. The modification of this technique by adding Cl_2 gas to the reaction mixture improves the yields in several cases drastically (up to 80 percent for bromo-guanosine and bromo-L-tyrosine). Similar improvement can be achieved by exposing crystalline $KBrO_3$ for some time to $CF_3{}^{82m}Br$ (or $CF_3{}^{80m}Br$) and dissolving subsequently the $KBrO_3$ in an acidic solution of the substrate. (auth)

2679 (CONF-750915-22) ELECTRONIC STRUCTURE OF URANYL COMPOUNDS: AN XPS STUDY. Veal, B. W.; Lam, D. J.; Hoekstra, H. R.; Carnall, W. T. (Argonne National Lab., Ill. (USA)). 1975. 9p. Dep. NTIS $4.00.

From 5th international conference on plutonium and other actinides; Baden-Baden, F.R. Germany (10 Sep 1975).

X-ray photoemission spectroscopy (XPS) measurements are reported for a series of uranyl compounds in which the primary uranium–oxygen (U–O_I) separation varies substantially. Crystal field splittings of the U $6p_{3/2}$ core electron energy levels were observed. These splittings are explained with the point charge crystal field model when both first and second near uranium neighbors are considered. The systematics of charge migration (observed by monitoring electron core level shifts) associated with bonding in the uranyl series were also investigated. Core level shifts for compounds with different U–O_I separations are large, but essentially no relative shifts of uranium and oxygen core levels were observed within the uranyl group. Thus charge appears to flow between the uranyl group (as a unit), and the secondary uranium ligands as U–O_I is varied. The U 5f electron participation in covalent bonding was also studied by systematically measuring XPS line intensities; U 5f electron occupation appears to be minimal. (auth)

2680 (LBL-4000, pp 331) CRYSTAL AND MOLECULAR STRUCTURES OF THORIUM AND URANIUM TETRAKIS (HEXAFLUOROACETONYLPYRAZOLIDE) COMPLEXES. Volz, K.; Zalkin, A.; Templeton, D. H. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

2681 (LBL-4000, pp 336-338) RADIOPOLAROGRAPHIC STUDIES OF Cf, Es, AND Fm. David, F. (Institut de Physique Nucleaire, Orsay, France); Samhoun, K. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

2682 (LBL-4000, pp 338-339) SOME THERMODYNAMIC PROPERTIES OF 5f ELEMENTS. David, F. (Institut de Physique Nucleaire, Orsay, France); Samhoun, K.; Guillaumont, R.; Nugent, L. J. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

2683 (LBL-4000, pp 340-342) MAGNETIC SUSCEPTIBILITY OF ^{249}Cf METAL. Fujita, D. K. (Oak Ridge National Lab., TN); Parsons, T. C.; Peterson, J. R.; Noe, M.; Edelstein, N. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

2684 (LBL--4000, pp 342-344) EPR OF Cf^{3+} IN OCTAHEDRAL SYMMETRY AND THE NUCLEAR DIPOLE MOMENT OF ^{249}Cf. Edelstein, N. (E. I. duPont de Nemours and Co., Aiken, SC); Karraker, D. G. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

2685 (LBL-4000, pp 344-346) REACTIONS OF DITHIOLATE LIGANDS WITH URANIUM (IV) HALIDES. Gradl, R.; Edelstein, N. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

2686 (LBL-4000, pp 346-347) SOME REACTIONS OF NEPTUNIUM HEXAFLUORIDE AND THE SYNTHESIS OF $NpOF_4$. Peacock, R. D. (The Univ., Leicester, England); Edelstein, N. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

2687 (ORNL–5050) CHEMICAL TECHNOLOGY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING MARCH 31, 1975. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 123p. Dep. NTIS $5.45.

Sixteen sections were abstracted separately. Twelve sections were announced in Nuclear Science Abstracts and ERDA Research Abstracts and four sections were announced in ERDA Research Abstracts only. Development of aqueous processes for LMFBR fuels, HTGR fuel recycle development program, molten-salt reactor program, and HTGR technology and safety programs are no longer covered in this report. (LK)

For abstracts of individual sections see: 2688, 2689, 2708, 2709, 2715, 2810, 3491, 3643, 3681, 3682, 4843, and 4844.

2688 (ORNL-5050, pp 25-26) PREPARATION OF $^{233}UO_2$. Oct 1975.

In Chemical Technology Division annual progress report for period ending March 31, 1975. (Oak Ridge National Lab., Tenn. (USA)).

Recovery of ^{233}U from waste UO_2 and scrap UO_2–ThO_2 pellets, ^{233}U purification systems, and conversion of ^{233}U from nitrate solution to ceramic-grade dioxide powder are discussed. (LK)

2689 (ORNL-5050, pp 72-78) STUDIES IN CHEMICAL ENGINEERING SCIENCE. Oct 1975.

In Chemical Technology Division annual progress report for period ending March 31, 1975. (Oak Ridge National Lab., Tenn. (USA)).

Measurements of mass transfer rates in open bubble columns; studies of oxidation of tritium as it permeates fusion reactor containment, flooding studies in columns filled with Goodloe packing, studies of mass transfer rates between water and mercury, preparation of small particles, and development of equipment are reported. (MCG)

2690 (ORNL-tr-4039(DR)) CHEMICAL SEPARATION OF NIELSBOHRIUM AS EKATANTALUM IN THE FORM OF ANHYDROUS BROMIDE. II. Experiments with Spontaneously Fissioning Nielsbohrium Isotopes. Zvara, I.; Belov, V. Z.; Domanov, V. P.; Shalaevskii, M. R. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1975. Translated by M. Gerrard from JINR-P6-8740. 11p. Dep. NTIS $4.50.

The behavior of nielsbohrium and niobium–bromine compounds was compared using the frontal thermochromatography technique. The nielsbohrium spontaneous fission isotope was produced by bombarding an americium-243 target with neon-22 ions. The niobium-90 isotope was produced simultaneously in nuclear reaction with bromine. The adsorption zone of nielsbohrium is formed at a slightly higher temperature as compared with niobium and tantalum. Similar results were obtained in previous investigations of the properties of chlorine compounds of element 105. This agrees with the expected properties of nielsbohrium as ekatantalum. (auth)

2691 (RT/CHI–(75)2) STRUCTURE OF COLLOIDAL SOLUTIONS OF THORIUM NITRATE. Magini, M.; Cabrini, A.; Di Bartolomeo, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). May 1975. 59p. (In Italian). Dep. NTIS (US Sales Only) $5.00.

The structure of highly hydrolyzed thorium salt solutions has been investigated by large and small-angle x-ray scattering techniques. The diffraction data obtained with large-angle measurements show the presence in solution of microcrystalline particles with the thorium oxide structure. Particles are larger than those discovered by small-angle measurements. A possible shape of these colloidal particles has been discussed. (auth)

2692 RAMAN SPECTROSCOPIC STUDY OF A PHASE TRANSITION IN $(TMA)_2UCl_6$ AND $(TMA)_2SnCl_6$. von der Ohe, W. (Department of Physics, University of California, Los Angeles, California 90024). J. Chem. Phys. 63: No. 7, 2949-2962 (1 Oct 1975).

A first order phase transition in $(TMA)_2UCl_6$ and $(TMA)_2SnCl_6$ with transition temperatures $T_{c1}=116$ and 142 K, respectively, upon decreasing and $T_{c2}=131$ and 156 K, respectively, upon increasing the temperature, is studied by Raman spectroscopy. The phase transition in $(TMA)_2SnCl_6$ is reported here for the first time. The Raman spectra of both crystals in both phases are incompatible with O^5_h, the space group indicated by x-ray investigations. In $(TMA)_2UCl_6$ the high temperature space group appears to be D^{11}_{2d}, the low temperature structure has either C^2_{4h} symmetry or a two-formula unit primitive volume. In $(TMA)_2SnCl_6$ one phase has a distortion containing a component of A_{2u} symmetry species, the other phase has a two-formula unit primitive volume. The structural changes involve at least two independent

distortions, one to be removed, the other one to be introduced. In neither crystal is the space group of one phase a subgroup of the space group of the other phase. The phase transitions are of first order on account of the symmetry change alone. They are of strongly first order, evidenced by the constancy of the peak frequencies above and below T_c, particularly of the frequency separations between neighboring bands, and by abrupt changes of the frequencies at T_c. The only band with a temperature dependent peak frequency, in the high temperature phase of $(TMA)_2SnCl_6$, is likely to be the soft mode of another phase transition of this crystal, occuring above its decomposition temperature. In the phase transitions under study vibrational bands appear and disappear by their intensity increasing from or decreasing to zero. Some bands which only exist in the high or low temperature phase, respectively, coexist over a temperature range of several degrees. In $(TMA)_2UCl_6$ the intensity change of two electronic Raman bands indicate a volume change at T_c of several percent. Preliminary scans of $(TMA)_2ZrCl_6$ at 90 and 300 K show that this crystal also undergoes a similar phase change. In the Appendix the equal cell subgroups of O^5_h are related to the symmetry species of the distortions having the form of a zone center vibrational eigenvector of the original structure. (auth)

2693 ELECTRONIC ENERGY LEVEL AND INTENSITY CORRELATIONS IN THE SPECTRA OF THE TRIVALENT ACTINIDE AQUO IONS. II. Cm^{3+}. Carnall, W.T.; Rajnak, K. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). J. Chem. Phys. 63: No. 8, 3510-3514 (15 Oct 1975).

The free-ion energy level scheme of Cm^{3+} (aquo) to ~40 000 cm^{-1} was determined. Energy level assignments were made based on the correlation between observed band intensities and those calculated using the Judd-Ofelt theory. Use of an expanded set of effective operators provided the basis for computation of free-ion energies in good agreement with the experimental assignments. (auth)

2694 STRUCTURES OF FLUORIDES. X. Neutron Powder Diffraction Profile Studies of UF_6 at 193°K and 293°K. Taylor, J. C.; Wilson, P. W. (Australian Atomic Energy Commission, Sutherland). J. Solid State Chem.; 14: No. 4, 378-382(Aug 1975).

Neutron diffraction studies on polycrystalline UF_6 have been carried out at 193°K and 293°K. At both temperatures, UF_6 is orthorhombic with the space group Pnma (D^{16}/sub 2h/) and Z equals 4. Measured lattice parameters are a equals 9.924 (10) A, b equals 8.954 (9) A, c equals 5.198 (5) A at 293°K and a equals 9.843 (11), b equals 8.920 (10), c equals 5.173 (6) A at 193°K. The neutron diffraction patterns were analyzed by the least-squares profile-fitting technique. On cooling, the hexagonal close-packing tends to become more regular, and the F-F distances external to a UF_6 octahedron contract. The octahedra are nearly regular with a mean U–F distance of 1.98 A, a mean F–F edge of 2.80 A, and a F–U–F angle of 90.0° at 193°K. (auth)

2695 CHEMICAL EFFECTS THAT ACCOMPANY NUCLEAR ISOMERIC TRANSFORMATION IN GAS-PHASE CH_4-$H^{80m}Br$ AND CH_4-$H^{82m}Br$ SYSTEMS. The Effect of Additives. Yagi, M.; Kondo, K. (Tohoku Univ., Sendai (Japan). Lab. of Nuclear Science). Kakuriken Kenkyu Hokoku; 7: No. 1, 179-183(Jun 1974). (In Japanese)

Various additives with different dipole moment were added to the CH_4–$H^{82m}Br$ system, and the results were compared with those in the case of CH_4–$H^{80m}Br$ system. On the latter system, examination was also made on the effect of the addition of various organic substances such as CH_3Cl, $CBrF_3$, and CCl_2F_2. The effect of addition was clearly noticed in case of CH_2^*BrBr. This result indicates that the formation of CH_2^*BrBr is caused by the reaction between CH_4Br^+ and HBr; $CH_4Br^+ + HBr \rightarrow CH_2BrBr + H_2^+$. When an inorganic substance having a dipole moment is present in a system, its ion cluster is possibly formed around CH_4Br^+ acting as a core. Formation of an ion cluster with inorganic compounds remarkably reduces the collision probability between CH_4Br^+ and HBr, and results in the decrease of the yield of CH_2BrBr. The yield of CH_3Br did not change by the addition of additives except that of HCl. This result indicates that the mechanism of formation of CH_3Br is different from that of CH_2BrBr. Therefore, the effect of additives originates not from the difference in ionization potential, but from the difference in ionization potential, but from the difference in dipole moment which plays an important role in the formation of ionic clusters. (JA)

2696 STUDY ON THE PRODUCTION OF Tm-167 OF HIGH SPECIFIC RADIOACTIVITY AND ITS CANCER- AND BONE-AFFINITY. Sakamoto, K.; Shirota, Y. (Kanazawa Univ. (Japan). Faculty of Science); Ando, A.; Hisada, K. Kakuriken Kenkyu Hokoku; 7: No. 1, 204-214(Jun 1974). (In Japanese)

The preparation of ^{167}Tm, which is excellent as a radioactive scanning agent of cancers and bones, was examined by means of $^{168}Yb(\gamma,n)\,^{167}Yb$, ^{167}Tm reaction, with the aid of a Linac. When the intensity of electron beam of 60 MeV was about 200μA, ^{167}Tm of about 50μ Ci/10 mg-target was obtained $^{168}Yb_2O_3$ target of 22.5% concentration. When a Yb_2O_3 target of natural isotopic abundance ratio was used, the radiation was about 20μ Ci/g-target. The time of irradiation was 7 hours in both cases. In order to prepare carrier-free ^{167}Tm, the conditions of elution were determined for the separation by cation exchange and precipitation with $YbSO_4$. Irradiation of 40 mg $^{168}Yb_2O_3$ for 22 hours with 200μA of 60 to 80 MeV electron beam gave ^{167}Tm with radiation of about 500μ Ci. This isotope was made carrier free, and injected to a rat having a Yoshida tumor, in the form of ^{167}Tm citrate. The intake percentage of the isotope in cancer, bone, and various organs was examined together with the change in course of time. It was found that ^{167}Tm showed cancer- and bone-affinity just as they were expected. (JA)

2697 CHEMISTRY OF THE TRANSPLUTONIUM ELEMENTS. Ishimori, T.; Umezawa, H. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment); Nishi, T.; Fujiwara, I.; Ikeda, N. Nippon Genshiryoku Gakkaishi; 16: No. 7, 349-38?(Jul 1974). (In Japanese)

Explanation is made on the stability of transplutonium elements, namely systematic nature of α disintegration, the effect of the change of spin on the α disintegration of even nuclei, the α disintegration of atomic nuclei with odd nucleons, systematic nature of spontaneous nuclear fission, and theories of spontaneous nuclear fission; methods of formation, namely irradiation of U targets, Am targets, and isotopic correlation technique; separation from each other, namely characteristics of separation, ion exchange method, and solvent extraction; properties, namely solid state chemistry on hydrides, oxides, Bk compounds, and Cf compounds, behavior of Am in solution including oxidation state, heterogenization, hydrolysis, complex formation, quantitative determination, and the identification of oxidation state; transplutonium elements present in natural environment, namely mechanism of formation, examples of study, and accumulation in natural environment; use of transplutonium elements, namely transplutonium elements in general and use of ^{252}Cf; safety in handling; health precautions, namely danger of transplutonium elements, the nature of radiation of transplutonium elements, and biological effects of the radiation, the characteristics of the metabolism of transplutonium elements, the standards to be set for the safe handling of transplutonium elements; and health precautions in the professional handling of transplutonium elements. (JA)

2698 PROCESS FOR PREPARING ^{99m}Tc-LABELLED ALBUMIN. Nakazawa, N.; Ogawa, H. (to Daiichi Radioisotope Labs., Ltd., Tokyo (Japan)). Japanese Patent 1974-21054/B/. 21 Nov 1970. 3p. (In Japanese)

A novel process for preparing ^{99m}Tc-labelled aggregated albumin (AA) or macroaggregated albumin (MAA) as a radio-isotope tracer is provided. The process comprises thermally denaturing albumin in the presence of ferric chloride or ferric hydroxide to give $(AA)_m$-$[Fe(OH)_3]_n$ or $(MAA)_m$-$[Fe(OH)_3]_n$, followed by isolating the latter and treating it with an aqueous solution of ^{99m}Tc-sodium pertechnetate and ascorbic acid to give ^{99m}Tc-AA or ^{99m}Tc-MAA. Since the labelling is effected in the final step of the process, operators can be largely protected against exposure risks. Yield of labelling is as high as 95% or higher so that the crude product may be directly administered without danger of reducing the selectivity with which a tracer is taken into a specific organ. In one example, a 25% solution of human serum albumin was treated with a hot solution of $FeCl_3$ at pH 5.5 to give MAA. After centrifugation, the precipitate was treated with ^{99m}Tc-sodium pertechnetate and ascorbic acid at pH 3.5 for 2 minutes and at pH 5.5 for 10 minutes. Thus, ^{99m}Tc-MAA was obtained in 95.64% yield based on ^{99m}Tc. After intravenous administration to rats, the percent of accumulations were: lung 93.14, liver 1.04, blood 2.16, and kidney 3.64. (JA)

2699 INTRAMOLECULAR EFFECTS OF RADIOIODINE DECAY IN o-IODOPHENOL, A MODEL FOR RADIOIODINATED PROTEINS. Jiang, V. W.; Krohn, K. A.; Welch, M. J. (Washington Univ., St. Louis). J. Am. Chem. Soc.; 97: No. 22, 6551-6556 (29 Oct 1975).

As a model for the chemical effects of the decay of radioiodine in iodinated proteins, [^{131}I-^{14}C]-o-iodophenol has been synthesized and the iodine-131 allowed to decay in aqueous solutions containing various phenolic additives. Reference samples were also studied in which the radioiodine was added as $^{131}I^-$ to [^{127}I-^{14}C]-o-iodophenol. Similar products were observed from hydrolytic deiodination of the o-iodophenol, radiolysis of the molecule by external radiation, and as a result of decay or organically bound iodine-131. A mechanism is proposed in which decay of the iodine in [^{131}I-^{14}C]-o-iodophenol leaves a carbonium ion [$C_6H_4(OH)^+$] which in solution reacts to form catechol. It is postulated that the other products formed are oxidation products of catechol. (auth)

Radioactive Waste Treatment

Refer also to abstracts 2627 and 3679–3681.

2700 (ANL-73-43) CHEMICAL ENGINEERING DIVISION WASTE MANAGEMENT PROGRAMS. Quarterly report, January–March 1975. Steindler, M. J.; Levitz, N. M.; Mecham, W. J.; Seefeldt, W. B.; Trevorrow, L. E.; Winsch, I. O.; Cannon, T. F.; Gerding, T. J.; Kullen, B. J.; Webster, D. S.; Burris, L. (Argonne National Lab., Ill. (USA)). Jun 1975. Contract W-31-109-Eng-38. 93p. Dep. NTIS $5.45.

Development work on the study of consolidation techniques for Zircaloy fuel-cladding hulls included scouting tests on volatility schemes for separating the zirconium as the volatile tetrachloride and ignition tests on several Zircaloy materials to further characterize the pyrophoric behavior of Zircaloy. All tests were with nonirradiated metal pending acquisition of irradiated samples. Installation is nearly complete of a glovebox facility for studies on the salvage of alpha-contaminated metals by pyrochemical methods. Disposal of a major portion of fission product tritium formed in light water reactor fuels by deep-well injection of the low-level aqueous waste from plants reprocessing such fuels is being evaluated. The question of siting is a very important factor in determining the feasibility of this particular disposal option. A review is given of the status of information for U. S. sedimentary basins, the areas most likely to be generally suitable for siting of waste wells. Work on the reliability of high-level-waste canisters included an examination of creep, shot-peening, and subcooling of the filler canister below storage temperatures as methods of relieving stresses induced in canisters due to differential contraction of canister and glass during cooling. Properties of fission product oxides were examined to elucidate possible adverse corrosive effects at the canister-waste interface. (LK)

2701 (ARH-LD-108) CALCINE CONVERSION FACILITY ALTERNATIVE CONCEPTS ENGINEERING STUDIES. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Feb 1975. Contract AT(45-1)-2130. 77p. Dep. NTIS $6.00.

The purpose of the engineering study reported is to develop conceptual designs for two alternative facilities for the conversion of high level waste calcine to high level glass. The objectives and design bases of the two concepts (CCF/RSSF and CCF/FRP) are described. No recommendation of one concept in preference to the other is given. (LK)

2702 (BNWL-1936) NUCLEAR WASTE MANAGEMENT AND TRANSPORTATION QUARTERLY PROGRESS REPORT, APRIL–JUNE 1975. Platt, A. M. (comp.). (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Sep 1975. Contract E(45-1)-1830. 75p. Dep. NTIS $5.45.

Research progress is reported on all Division of Waste Management and transportation funded programs at Battelle, Pacific Northwest Laboratories, with the exception of the Commercial Radioactive Waste Fixation Program. Topics reported on include advanced methods for management and disposal of radioactive wastes; separation of actinide elements from radioactive waste; decontamination and densification of chop-leach cladding residues; pyrolysis-incineration of combustible alpha wastes, tritium separation and fixation; characterization of 300 and WYE burial grounds; disposition of retired, contaminated facilities at Hanford; development of packaging technology for $Pu(NO_3)_4$ shipment; and transportation safety studies. (LK)

2703 (DP-1371) DISSOLUTION OF PuO_2 WITH CERIUM(IV) AND FLUORIDE PROMOTERS. Harmon, H. D. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. (USA). Savannah River Lab.). Oct 1975. Contract AT(07-2)-1. 31p. Dep. NTIS $4.00.

Ce(IV) in low concentrations is an effective promoter of PuO_2 dissolution in nitric acid solutions of approximately 3 to 6M. However, stoichiometric quantities of Ce(IV) are required for complete dissolution, and hydrothermal precipitation of CeO_2 is a potential problem at low acidities. Dissolution proceeds with oxidation of Pu(IV) to Pu(VI) with a corresponding reduction of Ce(IV). When an excess of Ce(IV) is present, the dissolution rate depends on Ce(IV) concentration below approximately 0.1M Ce(IV); above this concentration, the rate becomes fairly constant. Increased PuO_2 sintering temperature markedly reduces the dissolution rate in 4M HNO_3–0.15M Ce(IV). Preliminary results indicate stainless steel corrosion rates in Ce(IV)–HNO_3 solutions increase to significant values with increasing Ce(IV) concentration. In HNO_3–KF, the PuO_2 dissolution rate increases rapidly as the nitric acid and fluoride concentrations increase. The rate is decreased by increased PuO_2 sintering temperature and the presence of cationic species such as UO_2^{2+} and Fe^{3+}, which complex fluoride. Dissolution is much more rapid in HNO_3–KF solutions than in HNO_3–Ce(IV). Mixed KF and Ce(IV) in certain mole ratios in 8M HNO_3 gives more rapid dissolution than with Ce(IV) or KF alone; more Ce(IV) retards dissolution. In HNO_3–0.05M Ce(IV)–0.1M KF, the dissolution rate increases as HNO_3 concentration increases; below 6M HNO_3, the mixed system containing 0.05M Ce(IV)–0.1M KF is less effective than HNO_3–Ce(IV) or HNO_3–KF. Ruthenium, present in irradiated PuO_2, catalytically reduces Ce(IV) in nitric acid; thus, Ce(IV) will be ineffective for irradiated PuO_2–UO_2 fuel. In view of the ruthenium problem, HNO_3–F^- solutions appear most promising for breeder fuel processing. Nitric acid solutions containing Ce(IV) and Ce(IV)–F^- mixtures may be most useful for dissolving unirradiated PuO_2 and UO_2–PuO_2 materials, as in scrap recovery operations. (auth)

2704 (DP-1383) EVALUATION OF FLUORIDE, CERIUM(IV), AND CERIUM(IV)–FLUORIDE MIXTURES AS DISSOLUTION PROMOTERS FOR PuO_2 SCRAP RECOVERY PROCESSES. Harmon, H. D. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. (USA). Savannah River Lab.). Oct 1975. Contract AT(07-2)-1. 18p. Dep. NTIS $4.00.

Fluoride, cerium(IV), and cerium(IV)–fluoride mixtures were evaluated as promoters for nitric acid dissolution of unirradiated PuO_2 scrap. Fluoride was most effective in promoting rapid and complete dissolution of 80 to 160 g of PuO_2/liter of dissolvent. Cerium(IV) was unsuitable at the high PuO_2/dissolvent ratios normally used in scrap processing because high Ce(IV) concentrations or a Ce(IV) regeneration process were required. Mixing Ce(IV) and fluoride at a ratio of 4 KF/Ce(IV) in 8M HNO_3 increased the PuO_2 dissolution rate at PuO_2 concentrations of less than 10 g/liter, but not at the desired high PuO_2/dissolvent ratios. The dissolution rate of PuO_2 scrap in HNO_3–F^- and HNO_3–Ce(IV) solutions was related inversely to the temperature of the PuO_2 fabrication process. (auth)

2705 (DP-1397) EVALUATION OF GLASS AS A MATRIX FOR SOLIDIFICATION OF SAVANNAH RIVER PLANT WASTE. Kelley, J. A. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. (USA). Savannah River Lab.). Oct 1975. 21p. Dep. NTIS $4.00.

Laboratory tests using actual sludges collected from Savannah River Plant (SRP) waste tanks were performed to evaluate glass as a waste solidification matrix. Sludge was collected from three SRP waste tanks, washed to remove soluble salts, and then ground to a fine powder. From 25 to 40 wt percent of these sludges was vitrified into a borosilicate glass by melting at 1150°C. Substitution of 4 wt percent Li_2O for 4 wt percent Na_2O in the glass mix allowed higher loading of a high-aluminum sludge. No problems with phase separation were encountered, and all sludge components, except mercury which volatilized, appeared to dissolve completely in the glass melt. Volatilization of radionuclides during melting was 0.3 percent for ^{137}Cs, 2.9 percent for ^{106}Ru, and less than or equal to 0.01 percent for other nuclides. Initial leachabilities of glass products were low: 10^{-6} to 10^{-5} g/(cm²-day) for ^{137}Cs, ^{90}Sr, and alpha activity. Leachabilities decreased to 10^{-8} to 10^{-7} g/(cm²-day) in approximately 2 weeks. Heating the glasses at 600°C for 1 month caused devitrification which increased leachability, but durable waste forms still remained. This work showed that vitrification of SRP high-level waste sludges in borosilicate glass is feasible. Further investigation of melting concepts, scale-up, cost, long-term stability, and other factors are planned as a part of the development program for long-term waste management. (auth)

2706 (DP-MS-75-17) CONCENTRATION OF AQUEOUS RADIOACTIVE WASTE WITH WIPED-FILM EVAPORATORS. Goodlett, C. B. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. (USA). Savannah River Lab.). 1975. Contract AT(07-2)-1. 38p. (CONF-751107-2). Dep. NTIS $5.00.

From 68th annual meeting of American Institute of Chemical Engineering; Los Angeles, California, USA (16 Nov 1975).

Tests at the Savannah River Laboratory with two small wiped-film evaporators show that synthetic alkaline (Purex) waste can be converted to a free-flowing slurry that solidifies on cooling to ambient temperature. The desired concentration can be obtained in one pass rather than the several passes required with the bent-tube evaporators presently used at the Savannah River Plant. (auth)

2707 (DP-MS-75-19) SOLIDIFICATION AND STORAGE OF SAVANNAH RIVER PLANT RADIOACTIVE WASTE. Kelley, J. A.; Hale, W. H.; Stone, J. A.; Wiley, J. R. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. (USA). Savannah River Lab.). 1975. Contract AT(07-2)-1. 17p. (CONF-751107-5). Dep. NTIS $4.00.

A conceptual process for solidification of SRP aqueous waste into high-integrity, low-leachable forms was developed. The process separates about 99.9 percent of the biological hazard from approximately 97 percent of the waste. The major biological hazard remaining in the residual salt is ^{106}Ru, which has a 369-day half-life. Sludge and zeolite can be solidified into concrete or glass. Cost-risk analyses are being made to determine which of these forms is preferred for SRP waste. Also, studies on other parts of the conceptual process are in progress. (auth)

2708 (ORNL-5050, pp 27-35) SEPARATIONS CHEMISTRY RESEARCH AND DEVELOPMENT. Oct, 1975.

In Chemical Technology Division annual progress report for period ending March 31, 1975. (Oak Ridge National Lab., Tenn. (USA)).

Acylated pyrazolones in mixture with donor additions, such as TOPO and TBP, were examined as selective extractants for plutonium and the transplutonium actenides from acidic reprocessing waste solutions. Bifunctional phosphonates have potential applicability to separating americium, curium, and rare earths from all of the other fission products in fuel reprocessing wastes without prior destruction of the HNO_3. In the project to investigate the leaching characteristics of radium from uranium ores and sulfate-leached ore tailings, a study was made of the interrelation of the effective solubilities of calcium, strontium, barium, and radium sulfates. An improved flowsheet was devised for removal of americium and curium from reprocessing wastes. Since plutonium will be recovered from spent reactor fuels by the Purex, in which Pu(IV) is extracted into TBP from HNO_3 feed solution, experiments were designed to determine the stability of Pu(IV) in HNO_3 and in synthetic fission product solutions at various temperatures and acidities of interest. A study of the kinetics of the reduction of Np(VI) to Np(IV) in nitric acid solutions by ferrous nitrate was made using spectrophotometric methods. (LK)

2709 (ORNL-5050, pp 82-85) IODINE STUDIES. Oct 1975.

In Chemical Technology Division annual progress report for period ending March 31, 1975. (Oak Ridge National Lab., Tenn. (USA)).

A remote possibility exists that charcoal adsorbers in nuclear reactor installations would be required to retain larger quantities of radioactive iodine than normally adsorbed if certain postulated accidents occurred. An experimental program is being conducted to determine the effects that such loading would have on the retention of iodine (^{130}I used in study) and whether the resulting decay heat would ultimately lead to ignition of the charcoal. A study of the reaction of organic iodides with hyperazeotropropic nitric acid is oriented toward the planned LMFBR processing scheme, which includes the removal of iodine by 20 M HNO_3 (Iodox process). (LK)

2710 (SAND-75-5601) CERAMICS FROM ION EXCHANGERS: AN APPROACH TO NUCLEAR WASTE SOLIDIFICATION. Dosch, R. G. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1975. 3p. (CONF-751101-37). Dep. NTIS $4.00.

From joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

A waste solidification process involving inorganic ion exchange materials under development was tested on both simulated and actual high level waste streams. The process is based on a recently developed group of titanate, niobate, and zirconate inorganic ion exchange materials. After reaction with the waste stream, these materials can be consolidated and fired to form stable, ceramic solid waste forms. Decontamination factors of greater than or equal to 10^8 were obtained for cationic radionuclides and a tail-end anion exchange step lowered the activity in the process effluent to 0.1 to 1 mu Ci/ml, primarily attributable to ^{106}Ru. The solid waste (fully consolidated titanate form) generated by the process has a density of 4.6 g/cm^3 and a concentration factor of 1.1 g of waste oxides per cubic centimeter. The leaching and volatility characteristics of the solid are comparable to those observed for borosilicate glass waste forms. (JGB)

2711 CONTINUOUS VITRIFICATION OF CONCENTRATED SOLUTIONS OF FISSION PRODUCTS. Jouan, A.; Sombret, C. (CEA Centre de Marcoule, 30 - Bagnols-sur-Ceze (France). Dept. de Genie Radioactif). pp 252-254 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975).

The continuous vitrification process allows a calcinate flowing from a rotary kiln, and then a vitrified solid in a melting furnace connected to the preceding calciner to be obtained. The industrial calciner actually in operation has an evaporation rate of 40 liter/h. It consists of a bent rotating pipe, heated in an electric furnace with two fixed mouth pieces bearing gaskets. Remote disconnection of joints was studied to enable the equipment to be operated in a hot cell. The associated melting furnace is either a melting pot heated by induction of a melter of refractory materials. In the two cases, the glass bath is held by a thermic plug, which allows flow discharge into metal containers at regular intervals. Gases produced from the process are cleaned in wet-scrubbers. They are then condensed and the incondensable gases are neutralized. (FR)

2712 BITUMINIZATION OF RADIOACTIVE WASTES: SAFETY PROBLEMS AND APPLICATION FIELDS. Lefillatre, G. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France). Service de Chimie Appliquee); Leconnetable, J. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Protection contre les Rayonnements). pp 245-248 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975).

The bituminization of low and medium radioactive wastes has many advantages: volume and weight reduction; homogeneity of the solid obtained; good resistance to leaching (biological resistance to microorganisms, resistance to radiations); very favorable characteristics for transport and storage. The latest bituminization facility put into service at the CEA is that of the Saclay Center. The bituminization unit is located after a primary evaporator having a distillation capacity of 2m^3/h. It enables the coating of effluents at the rate of 601/h. (FR)

2713 MEDIUM LEVEL WASTE BITUMINIZATION PLANT AND ENGINEERED STORAGE FACILITY AT EUROCHEMIC. Detilleux, E.; Eschrich, H.; Balseyro (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)); Storrer, I.; De Beukelaer, R.; Van Averbeke, B. (Societe Belge pour l'Industrie Nucleaire, Brussels); Sank, E.; Joseph, C.; Smeyers (Comprimo Belgie, Antwerp (Belgium)). pp 246-249 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European Nuclear Conference; Paris, France (21 Apr 1975).

The solidification process consists of two main steps: chemical pretreatment to insolubilize the radionuclides to eliminate corrosion risks and uncontrollable thermic reactions; incorporation of the slurry, resulting from the chemical pretreatment, into bitumen with simultaneous evaporation of water to obtain solid bitumen wastes. The wastes are then poured into drums suited for interim storage and for final disposal. The drums containing radioactive wastes incorporated into bitumen are stored in buildings, the handling operations being completely remote controlled. The bituminization and storage installations are described, the hazards are evaluated and the safety aspects of the operations with regard to public health and environmental considerations are analyzed. (FR)

2714 PROCESS FOR CALCINING PACKING CONCENTRATED RADIOACTIVE LIQUID WASTE. Takeshima, M.; Murata, T.; Otabe, K. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1973-38680/B/. 13 Jan 1970. 4p. (In Japanese)

A process for temporarily halting the packing operation of a concentrated radioactive liquid waste from a fuel reprocessing plant or an atomic power plant is provided to promote the completion of the packing operation. When a waste liquid in a vertically disposed container is evaporated by heating while the liquid level is kept constant, this novel packing process comprises temporarily halting the supply of liquid during calcining packing and inserting a coating removal operation which removes cohered material from the surface of the inner wall and deposits it at the bottom of the container by melting. In one embodiment, during evaporation while supplying a waste liquid containing 25% sodium sulfate to a container 100 cm long and with an inner diameter of 30 cm, the packing operation is temporarily halted and the container is heated to a temperature higher than the melting point of the coating that has cohered to the inner surface of the container wall. A temperature of 866°C, for example, is higher than the melting point of sodium sulfate in the waste liquid. After the removal of the cohered coating, the temperature is once again lowered to the evaporation temperature to continue the evaporation of the following supply. As the heat resistance has been reduced in the wall of the container, the time required for the evaporation is shortened by as much as 25%. (JA)

Radioisotope Production

2715 (ORNL-5050, pp 20-23) TRANSURANIUM-ELEMENT PROCESSING. Oct 1975.

In Chemical Technology Division annual progress report for period ending March 31, 1975. (Oak Ridge National Lab., Tenn. (USA)).

Two target processing campaigns were conducted, and 23 HFIR targets were processed. Key isotopes in the campaign products are ^{243}Am, ^{244}Cm, ^{249}Bk, ^{252}Cf, ^{253}Es, and ^{257}Fm. Five sources containing from 0.9 mu g to 13 mg ^{252}Cf were fabricated. (LK)

Reactor Fuel Reprocessing

Refer also to abstracts 3005 and 3675.

2716 (CONF-750515-4) IDAHO CHEMICAL PROCESSING PLANT TRAINING PROGRAM. (Allied Chemical Corp., Idaho Falls, Idaho (USA). Idaho Chemical Programs–Operations Office). 1975. 21p. Dep. NTIS $4.50.

From 2nd symposium on training of nuclear facility personnel; Gatlinburg, Tennessee, USA (11 May 1975).

Objectives, regulations and requirements, training methods, certification and recertification, progression and incentives, and coverage of the ICPP operator training program are discussed in detail. (LK)

2717 (DOCKET-50332-52) BARNWELL NUCLEAR FUEL PLANT. License Application, FSAR, Amendment 6. (Allied-Gulf Nuclear Services, Barnwell, S. C. (USA)). Aug 1975. 458p. Dep. NTIS $26.00.

FSAR Amendment No. 6 consists principally of revisions of the portions relating to: (1) facilities for the interim storage of solid waste, (2) handling of spent iodine scrubber solutions, and (3) the use of N_2O_4 as an oxidizer. (LK)

2718 (DP-638) NEPTUNIUM BEHAVIOR IN SOLVENT EXTRACTION OF URANIUM AT SAVANNAH RIVER PLANT. Henry, H. E.; Karraker, D. G.; Schlea, C. S. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. (USA). Savannah River Lab.). Sep 1961. Contract AT(07-2)-1. 27p. Dep. NTIS $4.50.

Declassified 23 Apr 1973.

The solvent extraction behavior of neptunium in the processing of irradiated natural uranium (Purex process) and irradiated enriched uranium (HM process) at Savannah River was studied in the laboratory. Conditions were demonstrated for extracting neptunium in the first solvent extraction contactor of each process, and two methods were developed for partitioning neptunium from uranium in the HM process. (auth)

2719 (UCRL-77395) GENERATION OF FLOOR RESPONSE SPECTRA FOR MIXED-OXIDE FUEL FABRICATION PLANTS. Arthur, D. F.; Murray, R. C.; Tokarz, F. J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 9 Oct 1975. 20p. (CONF-751204-2). Dep. NTIS $4.50.

From ASCE specialty conference; New Orleans, Louisiana, USA (8 Dec 1975).

Floor or amplified response spectra are generally used as input motion for seismic analysis of critical equipment and piping in nuclear power plants and related facilities. The floor spectra are normally the result of a time-history calculation of building response to ground shaking. However, alternate approximate methods have been suggested by both Kapur and Biggs. As part of a study for the Nuclear Regulatory Commission horizontal floor response spectra were generated and compared by all three methods. The dynamic analyses were performed on a model of the Westinghouse Recycle Fuels Plant Manufacturing Building (MOFFP). Input to the time-history calculations was a synthesized accelerogram whose response spectrum is similar to that in Regulatory Guide 1.60. The response spectrum of the synthetic ground motion was used as input to the Kapur and Biggs methods. Calculations were performed for both hard (3500 fps) and soft (1500 fps) foundation soils. Results of comparison of the three methods indicate that although the approximate methods could easily be made acceptable from a safety standpoint, they would be overly conservative. The time-history method will yield floor spectra which are less uncertain and less conservative for a relatively modest additional effort. (auth)

2720 IN-LINE PROCESS CONTROL FOR REPROCESSING PLANTS: PRESENT STATUS AND FUTURE PROSPECTS. Edelin, J. C. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Services d'Electronique). pp 241-242 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975).

The main measuring instruments used in France for in-line checkout in fuel reprocessing plants are described: for physical and physico-chemical measurements (pH meters, electrodeless conductivity meters, capacitive probes); for radiometric measurements (γ counters, γ absorption meters, neutron counters, content meters). Projected or tested instruments are presented: for isotopic measurement of decontaminated uranium solutions; for measuring respective quantities of U and Pu in solutions; for measuring uranium traces in wastes. (FR)

2721 RADIOACTIVE WASTE TREATMENT AND DISPOSAL IN REPROCESSING PLANT AND RECOVERY OF USEFUL ISOTOPES. Hoshino, T. (Power Reactor and Nuclear Fuel Development Corp., Tokai, Ibaraki (Japan). Tokai Works). Genshiryoku Kogyo; 20: No. 11, 18-22(Nov 1974). (In Japanese)

The nuclear fuel reprocessing plant of Power Reactor and Nuclear Fuel Development Corporation is outlined. The method is wet Purex with 0.7-ton/day capacity as metallic uranium, the fuel to be processed has Zircaloy or stainless steel sheath, 28,000 MWD/T or more degree of burnup, up to 35 MW/T specific power, 180 days or more cooling, 4% or less uranium enrichment factor. Standard for fuel acceptance: maximum dimensions of fuel assembly 470 cm × 26 cm × 26 cm, maximum weight of fuel 1.2 t, cooling period at the time of acceptance 120 days or more, products purified uranium trioxide powder and purified plutonium nitrate solution. The process includes material acceptance and storage, decladding and dissolving, extraction and separation, refining, denitration of uranyl nitrate, and product storage. Radioactive liquid wastes produced in the reprocessing plant are divided into 3 levels namely high, medium and low, and undergo treatment and disposal separately. Radioactive gaseous wastes exhausted from the dissolution step and others are scrubbed, contaminants are removed from them by filtration, and they are exhausted to atmosphere while monitoring is carried out. Recovery of useful FP: 70 to 80 l/d Kr (^{85}Kr 8,000 Ci/d) and 90% or more of 600 l/d Xe will be removed and recovered, when a pilot plant for removing and recovering rare gas will be completed in the PRNFDC plant. ^{237}Np recovery technique from medium and low level liquid wastes has been developed, and 30 to 75% ^{237}Np can be expected to be recovered by slight modification of flowsheet and process conditions. (JA)

2722 PROBLEMS OF SAFETY IN NUCLEAR FUEL REPROCESSING. Takashima, Y. (Tokyo Inst. of Tech. (Japan)). At. Jpn.; 18: No. 5, Suppl. 1, 55-77(May 1974).

Investigation into the safety problem in a 1-5 tons per day nuclear fuel reprocessing plant is reported, by placing emphasis on the disposal of radioactive wastes. The analysis of spent fuel is based on the assumption as 4% of enrichment before burning, 28,000 MWD/T of burnup, 35 MW/T of specific power and 180 days of cooling period. Radioactivity is 3.3×10^6 Ci/ton. Fission products and Pu will be about 30 kg/ton U and 5 kg/ton U in weight, and U enrichment will decrease to 0.8–1.0%. Ocean discharge is restricted to less than 1 Ci/day or 65 Ci/3 months in Japan, which is 1/500 of British and French required figures. The radioactive effects of ^{85}Kr and tritium are reviewed. The effect of tritium is extremely small as compared with ^{85}Kr. The earliest installation of a ^{85}Kr removal equipment and a tritium removal device are wanted. The decontamination rate of iodine can be increased and the capture of noble gases can be facilitated by reducing the absolute quantity of off-gases. The character of the reprocessing plant as a facility of chemical industry, criticality control, radiation protection and control system, and accidents and their assessment are summarized. (JA)

2723 STUDIES ON SEPARATION OF METAL OXIDES WITH HEXACHLOROPROPENE. Kanno, T.; Hasegawa, S.; Ito, K. (Tohoku Univ., Sendai (Japan). Research Inst. of Mineral Dressing and Metallurgy). Kakuriken Kenkyu Hokoku; 7: No. 1, 215-218 (Jun 1974). (In Japanese)

The separation of uranium from nuclear fission products by a method which comprises the reaction of U_3O_8 with hexachloropropene at 100°C is reported. At this reaction temperature, U_3O_8 produces $UCl_5C_3Cl_4O_4$ or $UCl_6C_3Cl_6$, but other metal oxides do not undergo reaction. Samples used for the experiment were prepared by the radioactivation of ZrO_2, Nb_2O_5 and RuO_2 by photonuclear reaction, and 1% of each activated oxide was admixed with U_3O_8. 0.1 gram of the sample oxides was put in a small reactor. The gamma spectra were measured with a NaI(Tl) scintillation counter before and after the reaction with hexachloropropene at 100°C for 1 hr. The decontamination factor was calculated from the gamma peaks of ^{95}Zr, ^{92}Nb, and ^{103}Ru. Uranium was separated from zirconium with the decontamination factor of 500, from niobium with 300 and from ruthenium with 500. Another sample of U_3O_8 irradiated with the neutron beam from JRR-2 reactor and cooled for 250 days and diluted with unirradiated U_3O_8 did not show as large difference in gamma spectra as the above-described mixed oxides, and gave only 1.5 decontamination factor. This method can improve decontamination factor with 99% recovery of uranium. Further, the oxides of rare earth elements contained in fission products can hardly react with hexachloropropene. (JA)

CONTROLLED THERMONUCLEAR RESEARCH

2724 PLASMA PHYSICS INDEX, VOLUME 10, NO. 8, 1975. Biobligraphy, Author Index, Subject Index. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1975). 151p.

Plasma Confinement and Heating

Refer also to abstract 2796.

2725 (LA-UR-75-857) IMPLOSION AND STAGING SYSTEMS FOR A SCYLLAC FUSION TEST REACTOR. Gribble, R. F.; Linford, R. K.; Thomassen, K. I. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-ENG-36. 4p. (CONF-741178-2). Dep. NTIS $4.00.

From conference on energy storage, compression and switching; Torino, Italy (5 Nov 1974).

The implosion heating and adiabatic compression processes will be separated in future theta pinch devices. The circuit to achieve the fast implosion heating and power crowbar (staging) for the Scyllac Fusion Test Reactor is described here. The plasma is very tightly coupled to the circuit and presents a varying inductive load. Computer-aided circuit designs which achieve a programmed magnetic field waveform are described. The field approximates a two-step waveform, on-off-on, which is ideal for achieving the large initial plasma radius needed for stability. The components for the circuits have been developed and are being tested in experiments at Los Alamos. (auth)

2726 (MATT-1140) WAVE GENERATION AND HEATING NEAR ION CYCLOTRON FREQUENCY IN THE ST TOKAMAK. Takahashi, H. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1975. Contract E(11-1)-3073. 33p. Dep. NTIS $4.00.

The results of the recent, high power ICRH experiments performed on the ST Tokamak are reported. It was demonstrated that both the fast and slow waves could be generated in toroidal geometry, and heating of the plasma ions at power levels up to 1 MW was observed both at the ion cyclotron frequency (omega/sub ci/) and its second harmonic (2omega/sub ci/). Measurements by a charge exchange neutral detector directed tangentially to the plasma torus revealed that at 2omega/sub ci/ the ion energy within the bulk of the ion distribution function ("parallel body temperature") could be increased from about 100 eV up to 200 eV with efficiencies ranging from 8 to 45 percent. Efficiency at omega/sub ci/ in raising the parallel temperature was less than at 2omega/sub ci/. Charge exchange neutral detection perpendicular to the plasma column showed that both at omega /sub ci/ and 2omega/sub ci/ the "perpendicular body temperature" was enhanced very rapidly by a factor of up to 3. Also, buildup of a high energy "tail" in the ion energy distribution was observed. Power transfer to the ions seemed extremely efficient. (auth)

2727 PLASMA HEATING IN THE PRESENCE OF PARAMETRIC INSTABILITIES IN A MAGNETIC FIELD Porkolab, M.; Arunaslam, V.; Luhmann, N. C. (Princeton Univ., NJ). Plasma Phys.; 17: No. 6, 405-419(Jun 1975).

Heating of a magnetically confined plasma column in a mirror device is studied when high power microwave pulses are injected with frequencies well above the ion plasma frequency but below the electron plasma and the electron cyclotron frequencies. The fast heating times suggest that heating is due to parametric instabilities which are observed to occur during r.f. injection. The fundamental aspects of the parametric instability are in agreement with theory. It is found that in this frequency regime for pulse times of the order of 10 μsec or less, mainly the tail of the electron and the ion distribution function are heated. The number of particles populating these tails amount to a few percent (5 per cent) for the available input powers ($P \gtrsim 7$ kW). It is shown that the energy may be deposited either near the edge of the plasma column (surface modes) or throughout the whole plasma column depending on plasma parameters. (auth)

2728 TARGETS USED IN STUDIES OF HEATING AND COMPRESSION OF MATTER BY SPHERICAL IRRADIATION WITH LASER LIGHT. Gamalii, E.G.; Isakov, A.I.; Merkul'ev, Yu.A.; Nikitenko, A.I.; Rychkova, E.R.; Sklizkov, G.V. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). Sov. J. Quantum Electron. 5: No. 5, 568-570 (May 1975).

The main requirements which targets have to satisfy are formulated in accordance with the current theoretical ideas on the processes observed experimentally. A method is developed for the preparation of suspended spherical targets made of solid hydrogen and deuterium. A method for the preparation of polymer targets is suggested and tested: In this method small hollow thin-walled spheres are used. (auth)

2729 ELECTRON CYCLOTRON RESONANCE HEATING IN A PULSED MIRROR EXPERIMENT. Wyeth, N. C. (Delaware Univ., Newark, NJ); Lichtenberg, A. J.; Lieberman, M. A. Plasma Phys.; 17: No. 9, 679-688(Sep 1975).

Using a plasma, generated by contact ionization, in a pulsed mirror device, a microwave pulse is used for electron cyclotron resonance heating (ECRH). The average electron energy was found by measuring the x-ray bremsstrahlung spectrum from the plasma after peak compression, and the energy obtained was measured as a function of applied electric field. The results show a saturation of heating in agreement with the theory of ECRH of Lieberman and Lichtenberg (Lieberman, M. A. and Lichtenberg, A. J., (1973), Plasma Phys. 15, 125). Computer calculations of the average electron energy and the energy distribution were in good agreement with the experimental data. (auth)

2730 BEHAVIOR OF TOROIDAL PLASMA IN A ROTATING MAGNETIC FIELD. Shubaly, M. R.; Skarsgard, H. M. (Saskatchewan Univ., Saskatoon). Plasma Phys.; 17: No. 9, 637-644 (Sep 1975).

A toroidal system (R = 19 cm; a = 2.5 cm) has been constructed for an investigation of plasma containment by the combination of a steady toroidal magnetic field $B_z \leq 1.2$T) and a rotating transverse magnetic field ($B_\theta \leq 3$ mT; 1.85 MHz) of 2-pole configuration. An argon plasma ($p \sim 0.8$ mTorr; $n \sim 10^{18}$ m^{-3}; $T_e \simeq 10^5$°K; $T_i \simeq 300$°K) is pre-formed with a separate r.f. field which is terminated when the rotating field is applied. For low rotating field strengths, stable compression is observed. For $B_\theta > (B_\theta)_{crit} \simeq 0.8$mT, however, the behavior changes markedly. Rapid plasma heating occurs ($T_e > 3 \times 10^6$°K; $T_i = 1.1 \times 10^5$°K) and the density ($n \sim 10^{19}$ m^{-3}) corresponds to nearly full ionization. Under these conditions little compression is observed, a consequence, apparently, of the anomalous resistivity measured ($\sim 10^2 \times$ the classical value). (auth)

2731 CO_2 LASER INDUCED BREAKDOWN AND HEATING OF HYDROGEN IN A MAGNETIC MIRROR FIELD GEOMETRY. Offenberger, A. A.; Burnett, N. H. (Univ. of Alberta, Edmonton). Can. J. Phys.; 53: No. 14, 1360-1366(15 Jul 1975).

A 1 GW, 125 J CO_2 laser pulse focussed by a 10 cm f.l. parabolic mirror was used to induce breakdown and heating in 15 Torr hydrogen along the axis of a short 50 kG magnetic mirror field. Evolution of the breakdown plasma thus produced was studied by high speed photography, ruby laser Thomson scattering, and a Mach-Zehnder interferometer. Results indicate an efficient radial confinement of plasma by the mirror field with an electron temperature much enhanced over that resulting from a fieldfree breakdown. Interferometric measurements show that breakdown results in a cylindrical plasma with an electron density minimum on axis in both cases. A monitor of the transmitted CO_2 laser pulse indicates very incomplete coupling of laser radiation into the plasma column with the field applied, presumably due to refraction losses at the entrance boundary of the breakdown. (auth)

2732 DIFFUSION OF MULTICOMPONENT PLASMAS IN AXISYMMETRIC TOKAMAKS. El-Derini, Z. M. H. Madison, WI; Univ. of Wisconsin (1975). 131p. University Microfilms Order No. 75-16,309.

Thesis (Ph. D.).

The diffusion of impurities as well as alpha particles was analyzed in detail for both cylindrical and axisymmetric tokamaks in the banana regime. An estimate of the different species fluxes shows that with sufficient accumulation of an impurity the diffusion rate of the low Z ions is (m/sub i//m/sub e/)/sup 1/2/ greater than that of a simple plasma. This result is due to the friction between the different ion components of the plasma. The diffusion fluxes also show that the ions with higher charge will be concentrated in the center of the plasma while the lower Z ions will diffuse out. A sufficiently strong negative temperature gradient can reverse this effect. (Diss. Abstr. Int., B)

2733 TOKAMAK EXPERIMENT IN SPAC-II. Hamada, Y.; Mohri, A. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Jpn. J. Appl. Phys.; 13: No. 10, 1624-1629(Oct 1974).

A small scale tokamak type device named SPAC-II was constructed for the investigation of various problems in the confinement and heating of toroidal plasmas. In a tokamak mode experiment, plasma with the electron temperature of 180 eV is generated, when the plasma current is 18 kA and the safety factor q = 3.9. The energy confinement time is about 200 μs which is consistent with the scaling law of (plasma radius)^{2}x

(poloidal field). The current density is estimated to be 4×10^2 A-cm^{-2} for the parabolic distribution. (auth)

2734 CONFINEMENT OF TOROIDAL SCREW PINCH PLASMA IN ETL TPE-1. Ogawa, K.; Kiyama, S.; Maejima, Y.; Shimada, T.; Hirano, Y. (Electrotechnical Lab., Tanashi, Tokyo (Japan). Tanashi Branch). Denshi Gijutsu Sogo Kenkyusho Iho; 38: No. 3-5, 91-101(Jul 1974).

High beta plasmas in a temperature range of 50 to 80 eV were produced in the fast toroidal pinch experiment TPE-1 ($B_{\theta max}$ = 20 kG, I_{max} = 100 kA, the minor radius and major radius of the tube are 5 cm and 40 cm respectively). The experiments performed so far are mainly concentrated on a screw pinch configuration. The equilibrium is established experimentally and compared with a simple model. The stable plasma is observed photographically for about 35 μ sec in the cases of q = 1 to 1.2. In every case of screw pinch of q = 0.3 to 0.8, the instabilities start to grow after 5 to 10 μ sec from the initiation of the discharge. The plasma parameters (T_e, T_i, n_e), field configurations and their time histories were measured and compared with the computer simulations based on the two fluids model. The agreement between the experimental results and those of the computer simulations are fairly good in the compression phase. (auth)

2735 TOROIDAL PINCH APPARATUS ETL TPE-1. Ogawa, K.; Takeda, S.; Ikeda, N.; Kiyama, S.; Maejima, Y. (Electrotechnical Lab., Tanashi, Tokyo (Japan). Tanashi Branch). Denshi Gijutsu Sogo Kenkyusho Iho; 38: No. 3-5, 102-111(Jul 1974).

The experimental apparatus for the confinement of a high beta toroidal plasma in an axisymmetric magnetic system, ETL TPE-1, completed recently is described. TPE-1 is designed to study the confinement of a toroidal pinch plasma by a combination of axial (B_z) and aximuthal (B_θ) magnetic fields with an initial bias (B_z) field. The discharge tube is a pyrex glass torus of 80 cm in the major diameter and 10 cm in the minor diameter. It is surrounded by an aluminium alloy shell which has four flanges for feeding the fast I_z current (21 kJ, 40 kV). The thirty-six single turn I_θ coils surround the I_z shell and are connected to the main fast θ bank (160 kJ, 40 kV), preheat bank (0.8 MHz, 1.3 kJ, 40 kV) and bias B_z bank (2 kHz, 115 kJ, 5 kV) through six collector plates. The electrical insulation of coils has been successfully done by means of fluidized bed coating of epoxy powder. The toroidal plasma current is 100 kA, the I_θ current 4 MA, the maximum B_z field 20 kG and bias B_z field is 4 kG. The capacitor banks, the electrical and mechanical design of the load assembly, the construction of whole assembly and the testing results are described. (auth)

2736 VARIATIONAL METHOD IN THE TRANSPORT THEORY OF AN AXISYMMETRIC TOROIDAL PLASMA. Todoroki, J. (Nihon Univ., Tokyo. Dept. of Physics). J. Phys. Soc. Jpn.; 37: No. 4, 1115-1123(Oct 1974).

Neoclassical transport in an axisymmetric toroidal plasma is considered. By determining the poloidal dependence of ion mean velocity along the magnetic lines of force, the part of electron transport is separated from that of ions. Two kinds of variational principles, one being the maximum principle and the other being the minimum principle, are derived for each part of transport. The forms of variational functionals in the limits of large and small collision frequency are discussed. (auth)

2737 EFFECTS OF LOWER-HYBRID HEATING ON THE HOT ELECTRONS IN AN ELECTRON-CYCLOTRON-RESONANCE PLASMA. Shohet, J. L.; Hamann, J. R. (Univ. of Wisconsin, Madison). IEEE (Inst. Electr. Electron. Eng.) Trans. Plasma Sci.; PS-3: No. 3, 179-181(Sep 1975).

Experiments were performed on an electron cyclotron resonance plasma in a dc magnetic mirror to determine the effects of lower hybrid resonance radiation on the anisotropy of the plasma. It was found that the anisotropy of the plasma hot electrons decreased, the flux of hot electrons escaping through the mirror throats decreased and the midplane wall bremsstrahlung rate slightly increased as lower hybrid resonance power was increased. This is explained by observing that cold plasma, expelled by the lower hybrid radiation, decreases the number of scattering centers in the midplane, which results in a deeper diamagnetic well for the hot electrons. (auth)

2738 SIMPLE APPROXIMATE METHOD FOR ASSESSMENT OF DENSITY IN REFLECTED CONCENTRIC SHOCK-WAVES. Kaliski, S. Bull. Acad. Pol. Sci., Ser. Sci. Tech.; 23: No. 3, 99-103(1975).

Simple approximate formulas are submitted for appraisal of the density for concentric shock-waves, spherical and cylindrical, incident and reflected from the center in perfect gas. The appraisals obtained enable one to compute rapidly, for any γ, the compression with an error which does exceed a score percent, which is essential for rapid interpretation of experiments. (auth)

2739 AVERAGED THERMONUCLEAR BURNAL WAVE. Kaliski, S. Bull Acad. Pol. Sci., Ser. Sci. Tech.; 23: No. 2, 7-13(1975).

A simplified method for finding averaged analytic solutions is given for the problem of a burnal wave moving from the center of a D-T ball outwards as a result of concentric laser shock compression. Analytic solutions were found for the initial phase of the process, in which hydrodynamic and other effects are negligible. It is assumed in an approximate manner that the position of the burnal wave front and the penetration depth of α particles are identical. (auth)

2740 SELF-FOCUSING RELATIVISTIC ELECTRON STREAMS IN PLASMAS. Cox, J.L. Jr. (Department of Physics and Geophysical Sciences, Old Dominion University, Norfolk, Virginia 23508). Phys. Rev. Lett. 35: No. 14, 944-947 (6 Oct 1975).

A relativistic electron stream propagating through a dense plasma induces current and charge densities which determine how the stream can self-focus. Magnetic self-focusing is possible because stream-current neutralization, although extensive, is not complete. Electric self-focusing can occur because the stream charge becomes overneutralized when the net current is smaller than a critical value. Under some circumstances, the latter process can cause the stream to focus into a series of electron bunches. (auth)

2741 MICROWAVE HEATING OF ELECTRONS AND STABILITY OF A WEAKLY IONIZED PLASMA IN A MAGNETIC FIELD. Zhilinskii, A.P.; Smirnov, A.S. Sov. Phys.—Tech. Phys. 20: No. 2, 174-176 (Feb 1975).

It is shown experimentally that an increase in electron temperature produces a gradual stabilization of the afterglow of a weakly ionized plasma in a homogeneous magnetic field. Increasing T_e/T_i reduces the fluctuations in the plasma potential and density. For Te $\gtrsim (2\text{-}4) \cdot 10^3$ °K, the relative amplitudes are smaller than 10^{-2}—10^{-3} over the entire range of densities and magnetic fields that have been studied. The transverse diffusion coefficient is classical under these conditions. The experimental results are in qualitative agreement with theoretical ideas on the stability of a plasma against small-scale, drift instabilities, in which neutrality can be violated. (auth)

Plasma Diagnostics

Refer also to abstract 2794.

2742 (AED-CONF-75-043-033) BROADENING OF SOME He I AND He II LINES IN A PLASMA. Einfeld, D.; Sauerbrey, G. 1975. 6p. (In German) INIS.

From spring meeting of the Fachausschuesse Kurzzeitphysik and Plasma- und Gasentladungsphysik of the DPG; Duesseldorf, F.R. Germany (4 Mar 1975).

The broadening of the He I and He II lines was investigated in a wall-stabilized discharge (duration approximately 500 μs, Ne approximately 2×10^{16}cm^{-3}, T approximately 37,000 K). The xi factor calculated by Kriener and Schlueter could be used for the Ne determination from the continuum radiation. For the line width of the He I line 501.4 nm, the discrepancy of a factor 1.7 to Griem, Baranger, Kolb, Oertel reported by Kusch was confirmed. Also confirmed was the theoretical dependence of the distance between the group peaks on the electron densities for the He I lines 447.1 nm and 492.1 nm, first reported by Griem and Barnard et al. The line widths of the He II lines 320.3 nm and 408.6 nm are between the values given by Kepple and Griem, and Griem, Kolb, Shen. (GE)

2743 (IPP-III-17) DENSITY DISTRIBUTION MEASUREMENTS IN LARGE CTR DEVICES. Lisitano, G.; Morandi, P.; Cannici, B.; Rossetti, E.; Gottardi, N. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (F. R. Germany)). May 1975. 51p. (CONF-750959—1). Dep. NTIS (US Sales Only) $5.75.

From lectures on plasma diagnostics data acquisition systems; Varenna, Italy (3 Sep 1975).

Multichannel millimeter wave interferometry has been successfully applied to existing Tokamak discharges. The extension of this technique to the planned larger C.T.R. devices presents some technical problems which are discussed on hand of the experience gained in present day devices. (auth)

2744 (LA-UR-75-1344) X-RAY DIAGNOSTICS IN THE LASER-INITIATED FUSION PROGRAM. Godwin, R. P. (Los Alamos Scientific Lab., N. Mex. (USA)). Aug 1975. Contract W-7405-Eng-36. 58p. (CONF-750831-1;). Dep. NTIS $6.00.

From 24th annual conference on applications of x-ray analysis; Denver, Colorado, USA (6 Aug 1975).

The high-density and high-temperature plasma conditions required for successful laser-initiated fusion make x-ray diagnostics a valuable tool in this exciting field. Measurements of the

hard x-ray continuum emitted from laser targets provide insight into the complex laser-plasma coupling physics and the consequent energy transport through the bremsstrahlung signature of energetic electrons. X-ray techniques are important in the selection and assay of microballoon targets for current compression experiments. X-ray imaging experiments and diffraction spectroscopy of highly stripped atoms can provide information upon the symmetry, density and temperature of laser targets. Extremely high temporal and spatial resolution may be required for definitive diagnostic information on compressed targets. While laser-produced plasmas are interesting as possible intense x-ray sources and as a possible means of achieving x-ray lasing, those topics are outside the scope of this review. (auth)

2745 (LA-UR-75-1491) IMPLOSION MEASUREMENTS IN A HIGH VOLTAGE, LARGE DIAMETER, MEDIUM DENSITY THETA PINCH. Henins, I.; Hammel, J. E.; Jarboe, T. E.; Marshall, J.; Sherwood, A. R. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-Eng-36. 5p. (CONF-750944-5). Dep. NTIS $4.00.

From third topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Extensive sets of density measurements were obtained for two preionization levels with other parameters held constant (B equals 0.5 T, n_0 equals 4.8×10^{14} cm^{-3}, E/sub theta/ equals 1 kV/cm). The gross features of the implosion are similar in the two cases, but the density front is double-peaked for the higher preionization case. Generally, the particles move ahead of the driving magnetic field front, but some are also within this front. After reaching the axis the imploding plasma is observed to move outward again through the magnetic field in a manner suggesting anomalous transport. The particles stop at the outer radii. The total number of particles increases during the implosion and thereafter remains about constant. (auth)

2746 (LA-UR-75-1519) OPTICAL DIAGNOSTICS ON SCYLLAC. Freese, K. B.; Jahoda, F. C.; Kristal, R.; Seibel, F. T.; Siemon, R. E. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-ENG-36. 5p. (CONF-750944-17). Dep. NTIS $4.00.

From third topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The Scyllac toroidal theta pinch optical diagnostic complement consists of three types of measurements: plasma self-luminosity, laser interferometry, and laser light scattering. Each is described separately below. (auth)

2747 (MATT-1150) OBSERVATIONS OF INTERNAL RELAXATION OSCILLATIONS IN THE ADIABATIC TOROIDAL COMPRESSOR. Smith, R. R. (Princeton Univ., N. J. (USA). Plasma Physics Lab.). Oct 1975. Contract E(11-1)-3073. 17p. Dep. NTIS $4.00.

The soft x ray signal from the Adiabatic Toroidal Compressor (ATC) sometimes exhibits a 10 percent modulation with a frequency between 1 and 2 Kilohertz. The radial profile of the soft x ray signal and the electron temperature determined by laser scattering indicate that these fluctuations are associated with a limitation of the central electron temperature and a broadening of the temperature profile. By observing changes in the radial dependence of the relaxation oscillation during neutral injection, an increase of thirty to fifty percent in the radius where q equals 1 was measured. (auth)

2748 (N-75-15018) ION AND ELECTRON TEMPERATURES IN THE SUMMA MIRROR DEVICE BY EMISSION SPECTROSCOPY. Patch, R. W.; Voss, D. E.; Reinmann, J. J.; Snyder, A. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). 1974. 39p. (NASA-TM-X-71635; E-8169; CONF-741079-18). NTIS $3.75.

From 16th annual meeting of the plasma physics division of the American Physical Society; Albuquerque, New Mexico, USA (28 Oct 1974).

Ion and electron temperatures, and ion drift were measured in a superconducting magnetic mirror apparatus by observing the Doppler-broadened charge-exchange component of the 667.8 and 587.6 nanometer He lines in He plasma, and the H/sub alpha/ and H/sub beta/ lines in H2 plasma. The second moment of the line profiles was used as the parameter for determining ion temperature. Corrections for magnetic splitting, fine structure, monochromator slit function, and variation in charge-exchange cross section with energy are included. Electron temperatures were measured by the line ratio method for the corona model, and correlations of ion and electron temperatures with plasma parameters are presented. (auth)

2749 (N-75-16356) HEAVY ION BEAM PROBE MEASUREMENTS OF RADIAL POTENTIAL PROFILES IN THE MODIFIED PENNING DISCHARGE. Kambic, G. X. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). 1974. 24p. (NASA-TM-X-71643). NTIS $3.25.

From 16th annual meeting of American Physical Society; Albuquerque, NM (28 Oct 1974).

A heavy ion beam probe was used to examine the radial potential profile of a plasma in the modified Penning discharge. The plasma has strong (approximately kV) electrostatic potentials near the anode ring which can be a large fraction of the injected ion beam energy. A primary (singly ionized) thallium ion beam is injected through the plasma in the midplane of a double Penning anode ring. After passage through the plasma, primary and secondary (doubly ionized) ions are detected with either a set of flat probes or an electrostatic energy analyzer. A calculation of the primary orbit through the plasma is performed to obtain an approximation to the measured primary beam trajectory. As the real radial potential profile is unknown, an adjustable model is used in the computer program. The adjustable potential profile is varied until the best agreement between measured and calculated trajectories is obtained. Secondary orbits are also predicted using the best fitting adjustable profile. The calculations indicate that secondary beams originating at more than one point in the plasma can be simultaneously observed at the electrostatic analyzer with certain primary beam initial conditions. (auth)

2750 DIFFRACTION LIMITATIONS FOR PLASMA ELECTRON DENSITY MEASUREMENTS WITH SCHLIEREN METHODS. Dodel, G.; Kunz, W. (Institut für Plasmaforschung der Universität, D7 Stuttgart 80, Pfaffenwaldring 31, Federal Republic of Germany). Appl. Opt. 14: No. 10, 2537-2541 (Oct 1975).

Restrictions imposed by diffraction on schlieren electron density measurements are discussed. Applicability criteria are derived. It is shown that diffraction partly compensates for the advantage of longer wavelengths: while the deflection angles increase with λ^2, the gain in measuring precision increases only with $\sqrt{\lambda}$. The criteria are not restricted to a particular spectral range. However, they were derived with special regard to extending schlieren methods to the far infrared (auth)

2751 SIMPLE SWEPT DOUBLE PROBE FOR STREAMING PLASMA DIAGNOSTICS. Lee, J.J. (Laboratory of Plasma Studies, Cornell University, Ithaca, New York 14850). Rev. Sci. Instrum. 46: No. 11, 1591-1592 (Nov 1975).

A simple double probe for energetic plasma beam experiments (10^{16}/cm^3, 10 cm/μsec) is reported. By capacitive discharge, the probe can be used to obtain the entire I–V curve in a single shot, so that the electron temperature and the ion density can be easily estimated. For supersonic conditions, the ion saturation current is limited by the incident ion flux instead of the factor $(kT_e/M)^{1/2}$, as in the case of a stationary plasma. (auth)

2752 MAGNETIC PROBE FOR USE IN INTENSE ELECTRON BEAM ENVIRONMENT. Gerber, K.A.; Hammer, D.A.; Dove, W.F. (Experimental Plasma Physics Branch, Plasma Physics Division, Naval Research Laboratory, Washington, DC 20375). Rev. Sci. Instrum. 46: No. 11, 1593-1594 (Nov 1975).

A quartz housed, liquid dielectric insulated, magnetic probe capable of withstanding electron beam current densities exceeding 3.5 kA/cm^2 is described as it is employed on the "Triton" electron beam–plasma interaction experiment. (auth)

2753 EXPERIMENTAL AND COMPUTATIONAL STUDY OF THE LOW-DENSITY PLASMA IN THE OUTER REGIONS OF A THETA PINCH. Hafner, P.; Hofmann, F. (Ecole Polytechnique Federale, Lausanne (Switzerland)). Z. Angew. Math. Phys.; 25: No. 5, 667-672(25 Sep 1974).

From Swiss Physical Society spring meeting; Bern, Switzerland (26 Apr 1974).

The time evolution of the electron density has been measured in the outer regions of a fast theta pinch by means of a Mach–Zehnder interferometer. The results show that the electron density outside the central plasma column is relatively high, i.e. between 1 and 5×10^{14} cm^{-3}. A comparison of these measurements with theoretical calculations leads to the conclusion that the pinch must be unstable during the implosion phase. (auth)

2754 PLASMA DIAGNOSTICS WITH BERNSTEIN WAVES. Bitter, M.; Paris, P. J. (Ecole Polytechnique Federale, Lausanne (Switzerland)). Z. Angew. Math. Phys.; 25: No. 5, 677-681(25 Sep 1974).

From Swiss Physical Society spring meeting; Bern, Switzerland (26 Apr 1974).

This paper reports on plasma diagnostics with Bernstein waves, where Langmuir probes have been used as a supplementary tool. The plasma parameters have been determined for a series of discharge currents. The density values measured with Langmuir probes are smaller than those obtained with the Bernstein waves by a factor 2-3. A larger discrepancy exists with respect to the

measured values of the electron temperature. The value of about 5 eV for the parallel electron temperature measured with the flat probe has also been confirmed by measurements of the ion acoustic wave velocity. Therefore, it is concluded that the electron velocity distribution in the plasma shows considerable anisotropy. (auth)

2755 STUDY OF A HIGH FREQUENCY LINEAR DISCHARGE IN AN AXIAL MAGNETIC FIELD. Lietti, A.; Roux, M. (Ecole Polytechnique Federale, Lausanne (Switzerland)). Z. Angew. Math. Phys.; 25: No. 5, 674-677(25 Sep 1974). (In French).

From Swiss Physical Society spring meeting; Bern, Switzerland (26 Apr 1974).

A 15 kA discharge at 2.7 MHz is held for 5 μs between two cylindrical electrodes in a 114 × 15 cm tube in the presence of a 4 kG longitudinal magnetic field. (JS)

2756 DETERMINATION OF PLASMA DENSITY PROFILE AND OTHER PARAMETERS OF CYLINDRICAL PLASMA COLUMNS WITH AN ELECTROACOUSTIC PROBE. Olin, J. G. (General Motors Inst., Flint, MI); Chen, K. M. IEEE Trans. Plasma Sci.; PS-3: No. 3, 97-101(Sep 1975).

A new diagnostic method based on the excitation of thermal resonances using an electroacoustic probe was developed to determine the electron density profile and other plasma parameters of a cylindrical warm-plasma column. A coaxial electroacoustic probe is used to excite and detect the dipole and thermal resonances as the plasma density is varied. The electron density profile is expressed functionally in terms of unknown profile parameters. The profile and other parameters of the plasma column are then determined numerically based on some theoretical formulas and experimental results. (auth)

2757 ELECTRON DENSITY ESTIMATE OF TEA–CO_2 LASER PRODUCED PLASMAS IN AIR. Apostol, D.; Apostol, I.; Dragulinescu, D.; Grigoriu, C.; Mihailescu, I. N.; Morgan, I.; Nitoi, A.; Popescu, I. M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 20: No. 2, 185-187(1975).

Average electron density estimates of TEA–CO_2 laser-produced plasmas in air at atmospheric pressure using a gas laser interferometer were made. The basic geometry was that of a conventional Michelson interferometer in which the light source was an 18 mW 16328 Å He-Ne gas laser. A value of $(1 \pm 0.5) \times 10^{18}$ cm^{-3} was obtained for a laser incident energy of 5 J, and an electron density variation rate during the plasma expansion stage of (1 to 4) × 10^{17} cm^{-3} μs^{-1} could be also estimated from the interferograms. (auth)

2758 ELLIPSOID–HYPERBOLOID X-RAY IMAGING INSTRUMENT FOR LASER-PELLET DIAGNOSTICS. Chase, R. C.; Silk, J. K. (American Science and Engineering, Inc., Cambridge, MA). Appl. Opt.; 14: No. 9, 2096-2103(Sep 1975).

Analysis of an x-ray imaging system employing ellipsoid and hyperboloid mirrors that are confocal and coaxial indicates that spatial resolution of 1 to 3 mu m can be obtained. The useful field of view is hundreds of microns, and the collecting solid angle is at least 10^3 times that of a pinhole camera. The instrument has application to the diagnostics of laser-pellet interactions. (auth)

2759 SUBNANOSECOND TIME RESOLUTION DETECTION OF X–RAY PULSES USING CHEMICAL DOSIMETRY. Harney, R.C. (Lawrence Livermore Laboratory and Department of Applied Science, University of California, Davis-Livermore, Livermore, California 94550). J. Appl. Phys. 46: No. 10, 4453-4457 (Oct 1975).

The possibility of using chemical dosimetry to detect x-ray pulses with subnanosecond time resolution is theoretically investigated. The theory of chemical dosimetry is reviewed and a dosimeter consisting of a laser, an absorption cell, and an ultrafast optical streaking camera is analyzed. This analysis indicates that time resolutions of less than 100 psec are achievable at x-ray energies greater than 4 keV. Predicted threshold dose rates are low enough [(1–3) $\times 10^{13}$ rad sec^{-1}] so that the technique should be applicable to diagnostics of x-ray lasers, laser-produced x-ray experiments, and laser fusion experiments. Effects of photon energy, x-ray–induced solvent heating, high-Z doping of the solvent, cell length, and laser wavelength are discussed. (auth)

2760 PARTICLE-BEAM MEASUREMENT OF THE DENSITY OF NEUTRAL GAS AND PLASMA IN A PULSED COAXIAL ACCELERATOR. Kalmykov, A.A.; Timofeev, A.D.; Shevchuk, B.A. Sov. Phys.–Tech. Phys. 20: No. 2, 191-194 (Feb 1975).

The feasibility of measuring the neutral-gas and plasma densities and of determining their space–time distributions in a pulsed coaxial plasma accelerator is studied under varous operating conditions. The measurements are described. In fast operation of the accelerator the gas density before breakdown is lower, and the longitudinal density gradient is much higher, than in slow operation. The plasma density in the accelerator can reach $2 \cdot 10^{15}$ cm^{-3}. (auth)

Plasma Kinetics (General)

2761 POPULATIONS OF EXCITED LEVELS OF NON-HYDROGENIC IONS IN NON-THERMAL PLASMAS. Norton, B. A.; Wooding, E. R. (Royal Holloway Coll., London). J. Phys., B (London); 8: No. 11, 1973-1980(1 Aug 1975).

Parameters describing the deviations from LTE of the populations of excited levels of C II, C III, C IV and F II ions in isolated plasmas have been calculated. The values apply to plasmas with electron densities from 10^{15} to 10^{20} cm^{-3} and electron temperatures from 0.5 to 20 eV. Means of extending the data to lower densities and non-isolated plasmas at higher temperatures as well as to other ions in the same isoelectronic sequences are also described. (auth)

2762 COLLISIONAL-RADIATIVE RECOMBINATION IN COLD PLASMAS. Stevefelt, J.; Boulmer, J.; Delpech, J. (Groupe d'Electronique dans les Gaz, Institut d'Electronique Fondamentale, Bât. 220, Université Paris-XI, Centre d'Orsay–91405 Orsay, France). Phys. Rev. A 12: No. 4, 1246-1251 (Oct 1975).

We have investigated the electron-ion three-body collisional-radiative recombination for electron temperatures below 4000 °K using the Mansbach-Keck rates of electron-impact-induced transitions between hydrogenic energy levels of high principal quantum number. At such temperatures and for a wide range of electron densities, the statistical recombination process is simultaneously governed by collisional and radiative transitions between excited levels near the ionization limit, where many atomic and molecular systems possess a hydrogenic energy-level structure. In order to also take into account radiative transitions, we have numerically solved a system of coupled equations, describing the quasi-steady-state populations of 100 bound levels. These equations are expressed in, and solved for, the first differences between the reduced population densities ρ (p), which improves the computing precision and establishes the location of the "bottleneck" in the recombination sequence. Our results are consistent with the following approximation for the collisional-radiative recombination rate coefficient (in cm^{3}sec^{-1}): $\alpha_{cr} = 1.55 \times 10^{-10} T^{-0.63} + 6.0 \times 10^{-9} T^{-2.18} [e]^{0.37} + 3.8 \times 10^{-9} T^{-4.5} [e]$, where the electron temperature T is in °K and the electron density [e] is in cm^{-3}; the first and last terms describe purely radiative and collisional recombination, respectively, and the second term results from the complex interplay of collisional and radiative processes. Agreement with experimental data is reasonable. (auth)

2763 PLASMA FLOW IN A LARGE-DIAMETER ARC CHANNEL. Pakhomov, E.P.; Yartsev, I.M. (Institute of High Temperatures, Academy of Sciences of the USSR). High Temp. 13: No. 1, 28-31 (Sept 1975).

Experimental data are presented on the sensitivity of the laminar flow characteristics of a plasma of atmospheric pressure argon in the channel of a cold, wall stabilized, constant current arc (d=3 cm, L=175 cm) to the usually uncontrolled external factors of a constant perpendicular magnetic field (B=0–4 G), and a variable component of the voltage across the arc. (auth)

2764 NANOSECOND DISCHARGE IN A WEAKLY IONIZED PLASMA. Asinovskii, É.I.; Vasilyak, L.M.; Kirillin, A.V.; Markovets, V.V. (Institute of High Temperatures, Academy of Sciences of the USSR). High Temp. 13: No. 1, 32-35 (Sept 1975).

Energy absorption by a weakly ionized low-pressure plasma when a high-voltage nanosecond pulse is applied to it is investigated. It is observed that the resistance of the plasma remains large during the pulse and that the absorbed energy has a maximum with pressure and the delay between the breakdown and nanosecond pulses. (auth)

2765 POLARIZATION SHIFTS IN PLASMA. The Case of CaII. Tsuji, A. (Hiroshima Univ. (Japan). Dept. of Physics). J. Phys. Soc. Jpn.; 37: No. 4, 1098-1102(Oct 1974).

A quasi-static theory on the plasma polarization shift is developed by using the self-consistent field method. When the plasma-electron density is low and its temperature is high, the result obtained by this theory is proved to be identical with that of the monopole-interaction approximation in the impact theory. It is also shown that the isolated spectral line receives red shift. This is contrary to the results of the previous authors, but is confirmed by the energy levels of the screened Coulomb potential computed by Rogers et al. The evaluation is made for a spectral line (4s–4p) of CaII, as an example. (auth)

2766 COMPARISON OF NUMERICAL CALCULATIONS WITH MEASUREMENTS IN A LINEAR THETA PINCH. Sugisaki, K.; Sugiura, M.; Tamaru, T. (Electrotechnical Lab., Tanashi, Tokyo (Japan). Tanashi Branch); Kobayashi, S. Denshi Gijutsu Sogo Kenkyusho Iho; 38: No. 3-5, 76-90(Jul 1974). (In Japanese).

The plasma temperature was determined from the plasma diamagnetism. The results were compatible with those obtained with the particle energy analyser and through soft x-ray absorption measurements. The decay time of a plasma was mainly de-

termined from the thermal conduction loss due to a low temperature plasma outside the compression coil. The particle loss through coil ends was less effective than the thermal conduction loss for the decay of the plasma. Experimental data were compared with results of numerical calculations using a one-dimensional MHD computer program. The two agreed with each other fairly well during the time when sound waves propagated from the end of the coil to the center. (auth)

2767 ANNUAL REVIEW OF THE INSTITUTE OF PLASMA PHYSICS, NAGOYA UNIVERSITY. April 1973–March 1974. Nagoya Univ., Inst. Plasma Phys., Annu. Rev.; No. 1973, 1-121 ([nd]).

81 refs.

During this period, there were two functions in the Institute. The one was to finish works of three years projects since 1971, and the other was to make preparations for new next projects which will be run from the beginning of April 1974. (I) The main works carried out in this term are as follows: Regarding works on JIPP-I Stellarator, the toroidal discharge vessel was changed with the new one with l = 2 and l = 3, double helical fields. An experimental result on an arranged ohmic heating in the circular stellarator field was obtained. Also, one of behaviours of plasma losses was suggested from observations on a fluctuation which appears in JIPP-I with l = 3 Stellarator. A new beam source "Phoebus-I" for relativistic electrons was constructed and with this source a preliminary experiment was tried to inject a relativistic electron beam into SPAC-II. About pinch plasma experiments, Symmetric Toroidal Pinch, STP-II Machine and Caulked Cusp Torus, CCT-II Machine were newly constructed. Both of these machines were actively worked by using the capacitor bank of 200 kilojoules which was well designed. A narrow stability window of plasma produced in STP-II was observed between q = 1.3 and 1.5. Also, measurements on the plasma in CCT-II showed more large characteristic values than these obtained in CCT-I Machine. About the RF plugging, the most part of works was to construct new TPD-III Machine, which was installed within this period. The validity of preferential RF plugging was demonstrated fairly well in a multi-ion species plasma which was produced in TPD-II. From a theoretical point of view, a scheme of open system reactor was presented based on the use of cusp confinement with the adiabatic RF plugging. (II) Many projects were proposed to the programs extending over five years from 1974 to 1979 fiscal years. In them, the construction of JIPP-II torus, a fairly large device of hybrid configuration of Stellarator and Tokamak is adopted as a main project. The other research programs are as follows; the RF plugging experiment on a larger scale device, the high-beta toroidal experiments, the experiments on relativistic hot electron plasma and on laser-produced plasma, and application of high density relativistic electron beams. (auth)

2768 EXPERIMENTAL INVESTIGATION ON SUPERSONIC PLASMA FLOW THROUGH DIVERGING MAGNETIC NOZZLE. Yoshikawa, T.; Murasaki, T. (Osaka Univ., Toyonaka (Japan). Faculty of Engineering Science); Oda, G. Nippon Kikai Gakkai Rombunshu; 40: No. 339, 3139-3146(Nov 1974). (In Japanese).

The main purpose of this investigation is to clarify to what extent supersonic plasma flow can be controlled by diverging lines of magnetic force, to investigate whether the characteristics of supersonic plasma flow differ from those of a usual solid wall nozzle, and to find what is the mechanism of axial acceleration. The Hall coefficient of plasma flow for electrons, employed in this investigation, is larger than 1, and it is much smaller than 1 for ions. In this experiment, ion density distribution, electron temperature distribution, floating potential distribution and ion velocity were measured under the magnetic field of OG, 1000G and 2000G, respectively. Under the external magnetic field of 2000G, plasma flow flows along the diverging magnetic nozzle, and the rapid expansion of plasma — which is observed in the plasma flow with no external magnetic field — can be suppressed. But at the downstream of the magnetic nozzle, the plasma flow does not expand although the magnetic field diverges. Under the magnetic field of 1000G, plasma flow crosses the lines of magnetic force and causes strong Joule heating. From the measurement of ion density and ion velocity, it was clarified that ion flow rate was conserved, and this fact described that the reduction of the ion density due to recombination was very rare. (TAI, I)

2769 SOME PROBLEMS OF THE KINETICS OF A NEUTRAL CURRENT SHEET. Bulanov, S. V.; Syrovatskii, S. I. pp 88-107 of Neutral Current Layers in a Plasma. Moscow; Izdatel'stvo Nauka (1974). (In Russian)

Wave propagation of various types, beam instabilities, and the electromagnetic tearing mode instability in a neutral current sheet are examined, and dispersion equations for oscillations in a sheet are described. In a nonrelativistic approximation, it is shown that a neutral sheet situated within a nonstationary external electric field directed along the current will experience the tearing mode instability. In an ultrarelativistic approximation, the current sheet will be stable if the external field is increased quickly enough. Three simple models are constructed for acceleration of charged particles in neutral fields: acceleration of particles surrounding the plasma and of particles in the sheet during rapid collapse of the sheet and acceleration of particles during the incidence of an electromagnetic impulse of great enough amplitude on the sheet. A simple model describing collapse of a current sheet is examined, and the amplitude of the electric field formed in tearing is calculated. (IAA)

Plasma Kinetics (Experimental)

Refer also to abstract 3952.

2770 MEASUREMENT OF ELECTRICAL CONDUCTIVITY OF AIR PLASMA AT PRESSURES ABOVE 100 atm. Andreev, S.I.; Gavrilova, T.V. High Temp. 13: No. 1, 151-153 (Sept 1975).

In the present paper we report an experimental determination of the electrical conductivity σ $(\Omega \cdot cm)^{-1}$ of an air plasma at pressures $95 \leq p \leq 150$ atm in the temperature interval $13{,}400 \leq T \leq 18{,}100°K$. Under these conditions the number of particles N_D in a sphere of Debye radius is of the order of unity, and the theory of transport phenomena runs into the familiar difficulties. (auth)

2771 DEPENDENCE OF THE HALL EFFECT IN A NONEQUILIBRIUM PLASMA ON THE ELECTRON DENSITY. Golubev, V.S.; Dan'shchikov, E.V.; Lebedev, F.V. (I. V. Kurchatov Institute of Atomic Energy). High Temp. 13: No. 1, 167-169 (Sept 1975).

Measurements are reported of the effective conductivity and effective Hall parameter in a Ar-Cs plasma. (AIP)

2772 SPATIAL AND TEMPORAL BEHAVIOR OF ELECTRON TEMPERATURES IN LASER SPARKS IN NITROGEN, ARGON, AND HELIUM. Siegrist, M. R. (Australian National Univ., Canberra). J. Phys., D (London); 8: No. 10, 1177-1184 (11 Jul 1975).

Spatially resolved recordings of the plasma emission in a narrow spectral band and the absorption of an He-Ne laser probe beam have been used to deduce the electron temperature and estimate the density in sparks produced by a Q-switched Nd laser in nitrogen, argon, and helium at pressures from 0.5 to 4.5 atm. A uniform temperature decay with time constants of several hundred nanoseconds is observed in nitrogen and argon in the range of 5 to 1 eV, whereas in helium a secondary heat wave emerges from the initial breakdown zone ≈ 150 ns after breakdown. The temperatures obtained are in good agreement with published spectroscopic measurements under similar conditions. (auth)

2773 DENSITY SENSITIVE LINES OF HIGHLY IONIZED IRON. Doschek, G.A.; Feldman, U. (E. O. Hulburt Center for Space Research, Naval Research Laboratory, Washington, D.C. 20375); Davis, J.; Cowan, R.D. Phys. Rev. A 12: No. 3, 980-986 (Sept 1975).

Spectral lines from ions in the nitrogen isoelectronic sequence due to transitions of the type, $2s2p^4\ ^2D_{3/2,5/2}$-$2p^5\ ^2P_{3/2}$, and $2s2p^4\ ^2D_{3/2}$-$2p^5\ ^2P_{1/2}$, are identified in the 100-Å region in laser-produced plasma spectra of titanium (Ti XVI) through cobalt (Co XXI). It is proposed that the intensities of these lines relative to the intensities of lines of the same ions due to transitions of the type $2s^22p^3$-$2s2p^4$ are sensitive to electron density in the range from $\simeq 10^{18}$ to $\simeq 10^{20}$ cm^{-3}. Calculations are performed for Fe XIX, and a similar calculation is performed for a density-sensitive line ratio of Fe XIX, i.e., $(2s2p^5\ ^1P_1$-$2p^6\ ^1S_0)/(2s^22p^4\ ^1S_0$-$2s2p^5\ ^1P_1)$. This line ratio is also sensitive to electron density between about 10^{18} and 10^{20} cm^{-3}. The $2s2p^5\ ^1P_1$-$2p^6\ ^1S_0$ line is newly identified in Cr XVII, Co XX, and Ni XXI. (auth)

2774 COLLISIONAL RATE COEFFICIENTS FOR THE IRON IONS Fe VIII, Fe IX, AND Fe X. Datla, R.U.; Blaha, M.; Kunze, H. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). Phys. Rev. A 12: No. 3, 1076-1083 (Sept 1975).

Relative values of rate coefficients for excitation by electron collisions were determined experimentally for various transitions in Fe VIII, Fe IX, and Fe X at two plasma conditions in a small θ-pinch. Collisional ionization rates were also obtained for these ions. The maximum errors of the relative values of the excitation rate coefficients are estimated to be ±30% to ±40% and those of the ionization rates to be a factor of 1.5. Iron pentacarbonyl [Fe $(CO)_5$] was used as an impurity in hydrogen or helium gases. The electron temperature and density were obtained from the analysis of scattered laser light. They were in the range 60–150 eV and 10^{15} to 2×10^{16} cm^{-3}, although this

range was not available for each ion. The excitation rate coefficients were calculated by the use of the Coulomb-Born approximation. Comparison with experiment is made within each ion and also between ionization stages. A discrepancy in previous Coulomb-Born calculations is noted for the case of Fe VIII. (auth)

Plasma Kinetics (Theoretical)

Refer also to abstract 3725.

2775 (N-75-19020) STRONGLY MAGNETIZED CLASSICAL PLASMA MODELS. Montgomery, D.; Peyraud, J.; DeWitt, C. (Iowa Univ., Iowa City (USA). Dept. of Physics and Astronomy). 1974. 9p. (NASA-CR-136743). NTIS $3.25.

Discrete particle processes in the presence of a strong external magnetic field were investigated. These processes include equations of state and other equilibrium thermodynamic relations, thermal relaxation phenomena, transport properties, and microscopic statistical fluctuations in such quantities as the electric field and the charge density. Results from the equilibrium statistical mechanics of two-dimensional plasmas are discussed, along with nonequilbrium statistical mechanics of the electrostatic guiding-center plasma (a two-dimensional plasma model). (STAR)

2776 (TID-26878) GENERAL PLASMA PHYSICS II. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Apr 1974. Contract AT(11-1)-3073. 319p. Dep. NTIS $19.00.

Twenty eight lectures are given concerning various aspects of plasma confinement, equilibrium, diffusion, and stability in tokamaks. (MOW)

2777 CORRELATION FUNCTIONS OF A NON-ISOTHERMAL WEAK TURBULENT PLASMA. Abdulloev, Kh.; Makhankov, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Plasma Phys.; 17: No. 6, 421-434(Jun 1975).

An equation is derived for the correlation functions for non-isothermal plasma in the presence of quasi-steady Langmuir turbulence. This equation is studied to show that in the small wave number region $k \ll k_* = \omega_{pe}\nu_i/3v_e^2$ temporal-spatial correlation curve and its dependence upon k for the case $T_e \gg T_i$ is somewhat different from that at $T_e = T_i$. By contrast, in the wave number region $k > k_*$ the form and width of the correlation curve are determined almost entirely by the decay process $1 \rightarrow 1' + s$, which leads to a significant difference from the isothermal case. The correlation functions for ion-sound turbulence associated with Langmuir turbulence are discussed. (auth)

2778 IONIZATION BY ELECTRON IMPACT IN NONEQUILIBRIUM PLASMA IN ELECTRIC FIELD. Kruzhilin, N.A.; Yakubov, I.T. (Institute of High Temperatures, Academy of Sciences of the USSR). High Temp. 13: No. 1, 157-159 (Sept 1975).

Expressions for the ionization coefficient by electrons for a plasma in an external electric field are calculated on the basis of assumed distribution functions. (AIP)

2779 RELAXATION TIMES OF PERMEABLE PLASMAS. Lehnert, B. (Royal Inst. of Tech., Stockholm). Plasma Phys.; 17: No. 9, 689-698(Sep 1975).

The particle and energy balance is considered of plasmas which are permeable to neutral gas: (i) There exist two subclasses of permeable plasmas. The first includes "dilute" plasmas being penetrated by slow neutrals of wall temperature. The second includes "non-dilute" plasmas being penetrated only by fast neutrals having a temperature comparable to that of the ions. (ii) The energy and particle balance of dilute plasmas are strongly affected by plasma-neutral gas and plasma-wall interaction, as well as by the vacuum conditions, especially at long particle and energy containment times such as in the Spherator. Also the balance of non-dilute plasmas becomes affected by these interactions, but only to a limited extent in systems suffering from comparatively large losses such as Tokamaks. (iii) Earlier experiments with the Spherator can be explained by classical theory including plasma-neutral gas interaction, and need not be interpreted in terms of anomalous diffusion. Thus, the possibilities of the Spherator as a magnetic bottle have to be reconsidered. (auth)

2780 RELAXATION OF STRONGLY ANISOTROPIC MAGNETIZED PLASMAS BY ELECTROMAGNETIC ION-CYCLOTRON INSTABILITY. Cuperman, S. (Tel Aviv Univ., Israel); Sternlieb, A. Plasma Phys.; 17: No. 9, 699-705(Sep 1975).

A computer simulation is used to investigate the non-linear behavior of the electromagnetic ion cyclotron instability in a homogeneous plasma with (proton) parameters $\beta_{p\parallel} \equiv 8\pi n\, KT_{p\parallel}/B_0^2 = 1$ and $(T_\perp/T_\parallel)p = 100$. The results indicate (i) a fast buildup of left-hand (proton-like) polarized electromagnetic waves: the peak-value energy is about 230 times larger than the initial one and represents about 10% of the total energy in the system; (ii) a significant relaxation (isothermalization) of the initial thermal anisotropy value of 100 to a minimum value of about "3" (at peak field value); (iii) the establishment of a quasi-equilibrium state (from the collective point of view) in which the various (relative) energies in the system satisfy the following relations: $\overline{W}_{\perp,p} : \overline{W}_{\parallel,p} : \overline{W}_{\perp,e} : \overline{W}_{\parallel,e} : \overline{W}_B : \overline{W}_E = 0.819 : 0.105 : 0.032 : 0.017 : 0.046 : 0.003$. The above symbols represent total proton transverse and parallel kinetic energies, total electron transverse and parallel kinetic energies, total transverse magnetic wave energy and total longitudinal electrostatic wave energy, respectively. Each one of these energies is normalized to the total energy in the system. (auth)

2781 VARIATIONAL PRINCIPLES RELATED TO THE EQUILIBRIUM SHAPE OF A PLASMA IN AN AXISYMMETRIC TORUS. Teman, R. (Paris Univ., Orsay, France). Plasma Phys.; 17: No. 9, 707-711(Sep 1975).

A study of the equilibrium shape of a plasma confined in an axisymmetric torus with a perfectly conducting shell of arbitrary cross-section and with (or without) control field coils. This problem leads to a nonclassical, free boundary value problem for the flux function ψ. A variational, non-linear eigenvalue problem is posed whose solution defines the function ψ in the whole cavity, giving at the same time the boundary of the plasma and the values of ψ inside the plasma and in the vacuum. This approach is useful for the analytical study of the problem and also for its numerical solution. (auth)

2782 EQUILIBRIUM IN A MULTIPOLE TOKAMAK. Sakurai, K.; Tanaka, Y.; Okuda, T. (Nagoya Univ. (Japan). Faculty of Engineering). J. Phys. Soc. Jpn.; 37: No. 4, 1108-1114(Oct 1974).

A multipole Tokamak system consisting of the self-field due to a plasma current and an appropriate external magnetic field is considered. The solutions of the MHD equilibrium equation are computed by an approximate method. The plasma current is replaced by a ring current located at the magnetic axis in the first approximation. A numerical solution of the equilibrium equation for our system with a noncircular cross section is easily obtained by using the iterative method. Typical equilibria with an external magnetic field are discussed in relation to β_p. When the gradient of a vertical magnetic field is strong, the equilibrium plasma position in the horizontal direction is almost fixed, while that in the vertical direction is divergent. (auth)

2783 EXCITATION OF INHOMOGENEOUS PLASMA BY MODULATED CURRENT. Kalmykova, S. S. (Kharkov State Univ.). Izv. Vyssh. Uchebn. Zaved., Radiofiz.; 18: No. 5, 636-646(1975). (In Russian)

The excitation of longitudinal and transverse oscillations of a weakly-inhomogeneous plasma by the given modulated current is theoretically investigated. Analytical expressions are derived which determine the transient radiation amplitudes of this current in the inhomogeneous dielectric medium with the density profile of the transient layer type. These relations are used to analyze the dependence of the field amplitude of the transient radiation of one-dimensional longitudinal and two-dimensional transverse waves on the degree of the plasma inhomogeneity. (auth)

2784 PLASMA TRANSFER FUNCTIONS. Sen, A. K. (Columbia Univ., New York). IEEE Trans. Plasma Sci.; PS-3: No. 3, 163-167(Sep 1975).

The concept of transfer function which is so valuable for lumped dynamical systems is developed for plasma problems. Methods of construction of transfer functions for problems with boundary excitation as well as internal excitation are discussed. (auth)

2785 ELECTRON BEAM GENERATION IN PLASMA-FILLED DIODES. Miller, P.A.; Poukey, J.W.; Wright, T.P. (Sandia Laboratories, Albuquerque, New Mexico 87115). Phys. Rev. Lett. 35: No. 14, 940-943 (6 Oct 1975).

A study has been made of the response of low-density ($\sim 10^{13}$ cm^{-3}) plasmas when subjected to the very high electric fields of relativistic-electron-beam-accelerator diodes. An anomalous resistive behavior has not been seen. Instead, sheath formation at the cathode and electron-beam generation across the sheath has been found. This has important applications to the design of diodes for future electron-beam machines. (auth)

2786 STATISTICAL MECHANICS OF DENSE IONIZED MATTER. V. HYDRODYNAMIC LIMIT AND TRANSPORT COEFFICIENTS OF THE CLASSICAL ONE-COMPONENT PLASMA. Vieillefosse, P.; Hansen, J.P. (Laboratoire de Physique Théorique des Liquides, Université Pierre et Marie Curie, 4, Place Jussieu, 75230 Paris Cedex 05, France). Phys. Rev. A 12: No. 3, 1106-1116 (Sept 1975).

We study the static and dynamical correlations of density fluctuations in a classical one-component plasma (OCP), in the framework of thermodynamic fluctuation theory and linearized hydrodynamics. First we show that the fluctuations of the local electric field stabilize the OCP against density fluctuations, even when the compressibility becomes negative for $\Gamma \gtrsim 3$, where Γ is the usual plasma coupling parameter. Then, following closely the work of Mountain, we compute the dynamical structure factor in the hydrodynamic limit and show that the thermal Rayleigh peak vanishes in the long-wavelength limit, in agreement with recent molecular dynamics results. The shear and bulk viscosity coefficients η and ζ are calculated for large Γ in the framework of the "generalized hydrodynamics" formalism, using the known short-time expansion of the correlation functions. The coefficient η is found to exhibit a minimum as a function of Γ and ζ is found to be negligible compared to η in the OCP. (auth)

2787 COLLISIONAL AND ANOMALOUS DIFFUSION OF A WEAKLY IONIZED PLASMA IN A CYLINDER WITH CONDUCTING WALLS. I. Zhilinskii, A.P.; Kuteev, B.V. (M. I. Kalinin Leningrad Polytechnical Institute). Sov. Phys.—Tech. Phys. 20: No. 2, 163-169 (Feb 1975).

It is shown that when a weakly ionized plasma decays in a homogeneous magnetic field a conducting wall stabilizes the plasma. Stabilization is only observed with good contact between the plasma and the wall. In a stable plasma, up to magnetic fields $H \sim 2500$ Oe ($\Omega_i/\nu_{i,n} \gtrsim 2$) the lifetime is determined by classical ambipolar diffusion both parallel and perpendicular to the magnetic field, regardless of the material in the end walls (metal, dielectric). When $H > H_{cr}(\Omega_i/\nu_{i,n} > 2)$ an instability arises in the plasma. The diffusion perpendicular to H is accelerated. If an electric current is passed through the plasma it becomes unstable with $H < H_{cr}$. The "hard" regime of excitation is observed. The current-convective instability is a possible cause of the fluctuations. (auth)

Plasma Production

2788 EXPERIMENTAL INVESTIGATION OF NONSPHERICAL CUMULATIVE LASER PLASMA CONFIGURATIONS. Gribkov, V.A.; Krokhin, O.N.; Nikulin, V.Ya.; Semenov, O.G.; Sklizkov, G.V. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). Sov. J. Quantum Electron. 5: No. 5, 530-537 (May 1975).

The results are given of an experimental investigation of planar and quasicylindrical laser plasma cumulation. It is shown that when laser radiation is focused into a cone drilled in a solid target (and also in some cases of heating of a plane target), the dynamic heating is affected significantly by cumulative jets and parametric instability. (auth)

2789 LASER PLASMA ELECTRONS. Bykovskii, Yu.A.; Sil'nov, S.M.; Sharkov, B.Yu.; Shuvalov, S.M. (Moscow Engineering-Physics Institute). Sov. J. Quantum Electron. 5: No. 5, 538-541 (May 1975).

The results are given of an experimental investigation of the electron component of a laser plasma carried out using the time-of-flight collector method at large distances from the target. Extensive data are presented on the angular and energy spectra of the electrons in flight and on the dynamics of formation of electron spectra when the laser flux density is increased in the range $\sim 10^9$–5×10^{11} W/cm^2. A comparative analysis of the characteristics of the flight of electrons and ions in an expanding plasma is used to review the influence of the components on the expansion of a plasma bunch in a vacuum. The results obtained are essential in investigations of the formation of sharply focused beams of multiply charged ions for injection into accelerators and they should be useful in the determination of the fuller physical picture of the laser plasma expansion. (auth)

2790 INTERACTION OF RELATIVISTIC ELECTRON BEAMS WITH FUSION-TARGET BLOWOFF PLASMAS. Mosher, D. (Naval Research Laboratory, Washington, D. C. 20375). Phys. Rev. Lett. 35: No. 13, 851-854 (29 Sept 1975).

The relativistic Boltzmann equation with a Fokker-Planck collision term is solved assuming that elastic scattering characterizes the shortest time scale of the beam-plasma system. One-dimensional solutions containing the self-consistent return-current electric field show that, although range shortening occurs, the electric field prevents high-current-density beams from penetrating into the dense-plasma region. (auth)

2791 THE ROLE OF DISCRETE PLASMA INITIATION SITES IN THE HIGH-INTENSITY LASER IRRADIATION OF SURFACES. Nielsen, P.E. (Department of Physics, Air Force Institute of Technology (AFIT/ENP), Wright-Patterson Air Force Base, Ohio 45433). Appl. Phys. Lett. 27: No. 8, 458-459 (15 Oct 1975).

The total impulse delivered to solid surfaces through irradiation by CO_2 lasers of intensity greater than 10^7 W/cm^2 and pulsewidth of order 10^{-5} sec agrees well with theories which invoke the ignition of laser-supported detonation waves whose pressure scales on the 2/3 power of laser intensity, while the measured peak pressure under the irradiated area scales much more strongly with intensity. It is shown that these seemingly contradictory results may be reconciled through a model in which detonation waves are formed from discrete initiation sites whose size distribution determines the peak pressure scaling. (auth)

2792 OBSERVATION OF ANODE IONS ASSOCIATED WITH PINCHING IN A RELATIVISTIC ELECTRON BEAM DIODE. Swain, D.W.; Goldstein, S.A.; Kelly, J.G.; Hadley, G.R. (Sandia Laboratories, Albuquerque, New Mexico 87115). J. Appl. Phys. 46: No. 10, 4604-4605 (Oct 1975).

Ions originating at the anode of a relativistic electron beam (REB) accelerator are observed at the cathode by a means of a Faraday cup. The dominant species is H^+, probably from adsorbed impurities. These ions, having energies equal to the diode voltage, are not observed until 20–40 J/cm^2 are deposited by the beam on the anode surface, and are closely associated with the formation of a pinch at the anode. (auth)

2793 CORRELATION OF STRESS-WAVE PROFILES AND THE DYNAMICS OF THE PLASMA PRODUCED BY LASER IRRADIATION OF PLANE SOLID TARGETS. Krehl, P. (Poulter Laboratory, Stanford Research Institute, Menlo Park, California 94025); Schwirzke, F.; Cooper, A.W. J. Appl. Phys. 46: No. 10, 4400-4406 (Oct 1975).

The interaction of 20-nsec 300-MW pulses of 1.06-μm laser radiation with thick aluminum targets in vacuum has been studied. The time history of the target impulse has been measured with a Sandia quartz gauge. A time sequence of plasma density maps constructed from floating double-probe data has been used with measured expansion velocities to estimate the plasma momentum. The results show that the stress wave is predominantly produced by about 10% of the evaporated target material which is ionized and expands from the surface in the form of a hot plasma during and shortly after the laser pulse. The estimated momentum of the plasma and neutral emitted particles is 5.6 g cm/sec for a typical case compared with the measured target impulse of 6.1 g cm/sec. (auth)

2794 NEAR-FIELD MEASUREMENTS OF SUBNANOSECOND-CREATED LASER PLASMAS. Olsen, J.N.; Mendel, C.W. Jr. (Sandia Laboratories, Albuquerque, New Mexico 87115). J. Appl. Phys. 46: No. 10, 4407-4415 (Oct 1975).

The near field of expansion for plasmas created by a 40-psec 1.0–1.5-J laser has been probed to measure the electron density and local electric and magnetic fields. Holographic interferometry was used to measure the electron density in the range 10^{17} to 6×10^{18} cm^{-3} at delays of 2.5–22 nsec. Space-charge electric fields of up to 1900 V/cm were detected by deflection of a fast He^+ ion beam probe as late as 26 nsec after irradiation. Spontaneous magnetic fields of up to 50 G, rising in 10 nsec, were seen 4 mm from the target, decaying rapidly and often reversing at 8 mm. The temperature in the blowoff estimated from the combination of local electric field and electron-density scale length is high compared to predictions based on a peak $T_e = 160$ eV inferred from a multichannel soft x-ray spectral analysis. An anisotropic fast ion group appears in the interferometric density profiles and ejection of $\sim 10^9$ fast electrons is observed in the electric field measurements. These effects are compared to the early time ion collector signal and nonthermal x-ray spectrum, respectively. (auth)

Plasma Stability

2795 (MATT-1153) FINITE BETA AND RESONANT ELECTRON EFFECTS ON TRAPPED-ELECTRON INSTABILITIES. Tang, W. M.; Liu, C. S.; Rosenbluth, M. N.; Catto, P. J.; Callen, J. D. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1975. Contract E(11-1)-3073. 40p. Dep. NTIS $4.00.

Finite beta (plasma pressure/magnetic pressure) and resonant electron effects on the dissipative trapped-electron instabilities are analyzed. These modifications are shown to have a strong stabilizing influence on the finite ion gyroradius and electron temperature gradient driven modes, respectively. For relevant tokamak parameters complete stabilization may be possible. Stability criteria for radially local and nonlocal cases are presented. (auth)

2796 (MATT-1160) PARAMETRIC INSTABILITIES AND PLASMA HEATING IN AN INHOMOGENEOUS PLASMA. Porkolab, M.; Arunasalam, V.; Luhmann, N. C. Jr.; Schmitt, J. P. M. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1975. Contract E(11-1)-3073. 35p. Dep. NTIS $4.00.

Experimental studies of plasma heating due to microwave irradiation of the magnetically confined plasma column in the Princeton L-3 device is presented. X-band (10.4 GHz) microwave power, both in the ordinary and the extraordinary modes of propagation, is used in these experiments. Plasma heating is observed to occur simultaneously with the occurrence of parametric decay instabilities. The mode structure of the pump wave

and the decay ion wave dispersion has been measured with high frequency probes. Detailed measurements of electron heating rates are presented and compared with collisional heating rates. In addition, production of suprathermal electrons and ions is also observed and measured. A comparison is made with recent laser-pellet interaction experiments. (auth)

2797 (N-75-16351) HIGH-DENSITY CONSTRAINT ON THE ENTROPY INSTABILITY. Hudson, M. K.; Kennel, C. F. (California Univ., Los Angeles (USA). Inst. of Geophysics and Planetary Physics). Dec 1974. Contract N00014-69-A-0200-4050. 16p. (NASA-CR-42040; PPG-203). NTIS $3.25.

The entropy instability squared is a nonisothermal effect which is eliminated by parallel ion pressure at high densities (k sub z lambda sub e less than ½ sq root of m/M), reducing previous growth rate estimates and the range of unstable parameters. (auth)

2798 (N-75-16353) COLLISIONAL DRIFT MODE IN A PARTIALLY IONIZED PLASMA. Hudson, M. K.; Kennel, C. F. (California Univ., Los Angeles (USA). Inst. of Geophysics and Planetary Physics). Dec 1974. Contract N00014-69-A-0200-4050. 24p. (NASA-CR-141984; PPG-202). NTIS $3.25.

The structure of the drift instability was examined in several density regimes. Let sub e be the total electron mean free path, k sub z the wave-vector component along the magnetic field, and the ratio of perpendicular ion diffusion to parallel electron streaming rates. At low densities (k sub z lambda greater than 1) the drift mode is isothermal and should be treated kinetically. In the finite heat conduction regime square root of m/M less than k sub z Lambda sub greater than 1) the drift instability threshold is reduced at low densities and increased at high densities as compared to the isothermal threshold. Finally, in the energy transfer limit (k sub z lambda sub e less than square root of m/M) the drift instability behaves adiabatically in a fully ionized plasma and isothermally in a partially ionized plasma for an ion-neutral to Coulomb collision frequency ratio. (auth)

2799 (UCRL-Trans-10915) MODIFIED NEGATIVE-MASS INSTABILITY IN THE A. S. MACHINE. Zhurkovskii, V. G.; Timofeev, A. V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1974. Translation of IAE-2438. 24p. Dep. NTIS $4.50.

It is shown that the theory of modified negative-mass instability is capable of explaining the main features of the so-called second instability observed in the AS machine. Critical analysis of the theory has shown that this instability can develop only if the following condition is satisfied: eta/sub n/ equals n omega/sub i/lambda^2/4L^{2}OMEGA less than or equal to 1 where n is the number of the cyclotron harmonic, omega/sub i/ is the ion cyclotron frequency, lambda is the amplitude of ion oscillations between the trap mirrors, OMEGA is the frequency of these oscillations, and L is the characteristic scale of change in the magnetic field. (auth)

2800 SATURATION OF THE GENTLE BUMP INSTABILITY IN A RANDOM PLASMA. Escande, D.F. (Laboratoire de Physique des Milieux Ionisés, Groupe de Recherche du Centre National de la Recherche Scientifique, Ecole Polytechnique, 91120 Palaiseau, France). Phys. Rev. Lett. 35: No. 15, 995-998 (13 Oct 1975).

It is shown that as a result of density fluctuations, the phase velocity domain of the gentle bump instability can be greatly broadened, leading to a different saturation of the instability. A part of the beam is accelerated and the turbulence power at saturation is lowered. (auth)

2801 LOCALIZED MAGNETOHYDRODYNAMIC INSTABILITIES IN TOKAMAKS WITH NON-CIRCULAR CROSS SECTIONS. Weimer, K. E.; Frieman, E. A.; Johnson, J. L. (Princeton Univ., NJ). Plasma Phys.; 17: No. 9, 645-648(Sep 1975).

Evaluation of the Mercier stability criterion indicates that localized modes should impose few constraints on the possibility of using Tokamaks with non-circular cross sections. The importance of the details of the geometry in the vacuum region is noted. (auth)

2802 DYNAMICS OF WAVE INTERACTIONS IN BEAM–PLASMA SYSTEMS. Davydova, T. A.; Pavlenko, V. P.; Shamrai, K. P. (Inst. of Nuclear Research, Kiev). Plasma Phys.; 17: No. 9, 671-677(Sep 1975).

An investigation is made into the stabilization of "explosive" instabilities in beam-plasma systems. The stabilizing mechanism is a nonlinear frequency shift. The interaction of the waves is studied in the fixed phase approximation using second order perturbation theory. The correct mathematical procedure is established for obtaining the second order equations for the wave amplitudes using a multiple time scale formalism. For the beam-plasma system considered here, the maximum amplitude values and the characteristic times between "flashes" in the interacting wave amplitudes are obtained. The theory which is developed is applied to a wide range of parameter values for the plasma and the electron beam. (auth)

2803 STABILIZATION OF m = 1 HELICAL INSTABILITY BY MEANS OF FEEDBACK FIELD. Fukutani, Y.; Kurita, G.; Oshiyama, H. (Kyoto Technical Univ. (Japan)). J. Phys. Soc. Jpn.; 37: No. 4, 1103-1107(Oct 1974).

A method is presented for theoretically stabilizing the m = 1 helical-mode instability of the current-carrying plasma; the method consists in applying the controlled helical feedback field, proportional to the displacement. The normal-mode method including the restoring force due to the feedback field is adopted in order to investigate the stability criterion; it is shown that the plasma can be stabilized if the feedback gain G satisfies the condition in the absence of the conducting wall $G > (2nq(1-nq)/\alpha+nq)$, where the parameter α represents the current distribution, n is the mode number of the longitudinal direction and q the safety factor. The example of G is calculated for a Tokamak-type plasma. (auth)

2804 STABILIZATION OF DRIFT INSTABILITIES OF INHOMOGENEOUS PLASMA BY MEANS OF AN RF ELECTRIC FIELD. Aghevli, R. (Teheran Polytechnic). IEEE Trans. Plasma Sci.; PS-3: No. 3, 144-150(Sep 1975).

The possibility of stabilizing effects that an rf electric field imposes on drift instabilities in an inhomogeneous plasma is investigated. A two-species, nonisothermal plasma, situated in an externally applied static magnetic field is considered with the rf electric field applied in the same direction as the dc magnetic field. The plasma is "mildly" inhomogeneous in density, with a density gradient perpendicular to the confining magnetic field. Using a hydrodynamic model for the plasma it is found that under certain conditions an increase in the frequency of the drift oscillations is obtained as the result of the application of the rf electric field. The increase in the frequency of the drift oscillations results in an increase in the magnitude of the stabilizing term associated with Landau damping which in turn yields a smaller growth rate for the drift instability. Discussions of the state of the plasma for different values of the frequency of the applied electric field are presented and the feasible ranges of values of the above quantity required for stabilization are determined. It is concluded that the resulting stabilization is significant only in a very narrow rf band. Therefore, the application of this technique appears to be a difficult experimental undertaking. (auth)

2805 EXPLOSIVE INSTABILITY OF ELECTROMAGNETIC WAVES IN A NONEQUILIBRIUM MAGNETOACTIVE PLASMA. Karashtin, A. N.; Reutov, V. P. Izv. Vyssh. Uchebn. Zaved., Radiofiz.; 18: No. 7, 930-934(1975). (In Russian)

An explosive instability arising from interaction between two electromagnetic waves and a wave of a spatial charge of the negative energy in a magnetoactive plasma with the beam is studied. A contribution of relativism into the nonlinear interaction is estimated. The estimations are presented for the increments of the explosive instability and the time of explosion. Possible realizations are discussed. (auth)

2806 FLUTE INSTABILITIES IN TWO-DIMENSIONAL SIMULATIONS OF STRONGLY INHOMOGENEOUS THETA-PINCH PLASMAS. Winske, D.; Hewett, D.W. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). Phys. Rev. Lett. 35: No. 14, 937-940 (6 Oct 1975).

Particle simulations initialized with inhomogeneous, self-consistent Vlasov equilibria that model theta pinches in the implosion and post-implosion phases have revealed a strongly unstable flute mode for $T_i > T_e$. Frequencies and wavelengths are in good agreement with the linear theory of the lower-hybrid-drift instability. Results agree with quasilinear estimates of heating rates and anomalous resistivity during the initial stages of the instability. The nonlinear saturation of the turbulence is consistent with ion trapping. (auth)

2807 STRONG COUPLING OF PARAMETRIC INSTABILITIES OF A COLD MAGNETIZED PLASMA WITH AN INTENSE ELECTROMAGNETIC WAVE IN RAMAN SCATTERING. Pustovalov, V.V.; Romanov, A.B. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). Sov. Phys.—Tech. Phys. 20: No. 2, 141-144 (Feb 1975).

The aperiodic instability in a cold, magnetized plasma due to strong coupling of electrostatic waves at the upper and lower hybrid frequencies with an intense pump wave is analyzed with the linear theory for parametric resonances. A new spectrum of electrostatic perturbations is found; these perturbations propagate across the magnetic field and are driven by both the electromagnetic pump wave and the fixed external field. The analytic results are illustrated by a numerical calculation. (auth)

Thermonuclear Engineering and Equipment

Refer also to abstracts 2689, 2812, 2856, 2858, and 2859.

2808 (MATT-1166) DISCRETE COIL TORUS WITH LOWER FIELD RIPPLE. Sheffield, G. V. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1975. Contract E(11-1)-3073. 9p. Dep. NTIS $4.50.

A new toroidal field coil configuration is described which allows one to reduce the volume of a toroidal field coil system or the number of coils constituting such a system without increasing the toroidal field ripple. (auth)

2809 (MATT-1170) PROSPECTS FOR THERMONUCLEAR IGNITION IN A "COLLISIONAL" TOKAMAK. Cohn, D. R.; Jassby, D. L.; Parker, R. R. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1975. Contract AT(11-1)-3073. 15p. Dep. NTIS $4.00.

The parameters are described for a tokamak reactor plasma that attains ignition in the same regime of collisionality as present-day ohmic-heated tokamak plasmas, where the confinement scaling ntaualphan^2 is observed. The use of Nb_3Sn toroidal field coils and a plasma elongation greater than or equal to 1.5 are necessary to attain the high plasma density (n approximately 10^{15} cm^{-3}) required for ignition in this collisional regime. Under these conditions, the fusion power density is of order 10 W/cm^3. This high value is probably necessary for an economic tokamak reactor. (auth)

2810 (ORNL-5050, pp 79-81) CONTROLLED THERMONUCLEAR PROGRAM. Oct 1975.

In Chemical Technology Division annual progress report for period ending March 31, 1975. (Oak Ridge National Lab., Tenn. (USA)).

Brief discussions are given for the following four areas of research: (1) tritium handling system for an experimental fusion power reactor, (2) preparation for tests of cryosorption pumping for fusion reactors, (3) tritium sorption studies, and (4) tritium sorption in Li–Al and Li–Bi alloys. (MOW)

2811 (ORNL-TM-4777) EXPERIMENTAL ENGINEERING SECTION SEMIANNUAL PROGRESS REPORT (EXCLUDING REACTOR PROGRAMS), MARCH 1, 1974–August 31, 1974. Scott, C. D.; Burtis, C. A.; Pitt, W. W.; Ryon, A. D.; Watson, D. C.; Watson, J. S. (comps.). (Oak Ridge National Lab., Tenn. (USA)). Jul 1975. Contract W-7405-eng-26. 263p. Dep. NTIS $16.25.

The following projects were studied: centrifugal fast analyzer development; advanced analytical techniques for wastes and biological materials; bioprocesses; water pollution; tritium processing; a tritium handling system for CTR program, and coal conversion process development. Six sections have been announced in ERDA Research Abstracts and 2 sections have been announced in Nuclear Science Abstracts. (PCS)

For abstracts of individual sections see: 2592 and 2812.

2812 (ORNL-TM-4777, pp 203-217) CONTROLLED THERMONUCLEAR PROCESSING. Jul 1975.

In Experimental Engineering Section semiannual progress report. (Oak Ridge National Lab., Tenn. (USA)).

Brief discussions are given on research progress during this report period for the following two topics: (1) conceptual design of a tritium handling system for Ormak F/BX, and (2) design of, and preparation for, tests of cryosorption pumping for fusion reactors. The status of the program is outlined. (MOW)

2813 (UCID-16941) DT FUSION NEUTRON IRRADIATION OF WRDC ELECTRON MICROSCOPY SAMPLES, LLL SUPRACIL SAMPLES, AND LLL ALUMINUM TENSILE SPECIMENS. MacLean, S. C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Sep 1975. Contract W-7405-Eng-48. 8p. Dep. NTIS $4.00.

The experimental parameters using 14-MeV neutrons from the LLL Rotating Target Neutron Source are described for the above specimens are presented. No results are given. (MOW)

2814 (UCRL-77003) TWO METHODS OF SPACE-TIME ENERGY DENSIFICATION. Sahlin, H. L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Jul 1975. 39p. (CONF-741178-3). Dep. NTIS $5.00.

From conference on energy storage, compression and switching; Torino, Italy (5 Nov 1974).

With a view to the goal of net energy production from a DT microexplosion, two ideas (methods) are studied through which (separately or in combination) energy may be "concentrated" into a small volume and short period of time–the so-called space-time energy densification or compression. The advantages and disadvantages of lasers and relativistic electron-beam (E-beam) machines as the sources of such energy are studied and the amplification of laser pulses as a key factor in energy compression is discussed. The pulse length of present relativistic E-beam machines is the most serious limitation of this pulsed-power source. The first energy-compression idea discussed is the reasonably efficient production of short-duration, high-current relativistic electron pulses by the self interruption and restrike of a current in a plasma pinch due to the rapid onset of strong turbulence. A 1-MJ plasma focus based on this method is nearing completion at this Laboratory. The second energy-compression idea is based on laser-pulse production through the parametric amplification of a self-similar or solitary wave pulse, for which analogs can be found in other wave processes. Specifically, the second energy-compression idea is a proposal for parametric amplification of a solitary, transverse magnetic pulse in a coaxial cavity with a Bennett dielectric rod as an inner coax. Amplifiers of this type can be driven by the pulsed power from a relativistic E-beam machine. If the end of the inner dielectric coax is made of LiDT or another fusionable material, the amplified pulse can directly drive a fusion reaction–there would be no need to switch the pulse out of the system toward a remote target. (auth)

2815 NUCLEAR FUSION POWER AND THE ENVIRONMENT. Hirsch, R. L.; Rice, W. L. R. (Atomic Energy Commission, Washington, DC). Environ. Conserv.; 1: No. 4, 251-262(Win 1974).

The physics problems remaining to be solved to achieve practical fusion power by magnetic confinement techniques are believed to be well posed and soluble. A programme plan recently developed in the United States calls for progressively larger plasma confinement experiments to address these physics questions in line with a serious programme in fusion power engineering. Implementation of the plan is expected to lead to the first production of power from a deuterium–tritium-fuelled system in 1980. Thereafter three progressively larger experimental electrical power reactors are planned, leading to fusion power commercialization in the later 1990s. (auth)

2816 CONTROL STRATEGY FOR PLASMA EQUILIBRIUM IN A TOKAMAK. Miskell, R. V. Knoxville, TN; Univ. of Tennessee (1975). 125p. University Microfilms Order No. 75-18,975.

Thesis (Ph.D.).

The dynamic control of the plasma position within the torus of a Tokamak fusion device is a significant factor in the development of nuclear fusion as an energy source. This investigation develops a state variable model of a TOKAMAK thermonuclear device, suitable for application of modern control theory techniques. The model considers eddy currents in the conducting shell surrounding the torus and the classical Shafranov equilibrium equation. The equations necessary to characterize the operating conditions of a TOKAMAK are cast in state variable form. Two control variables are selected, the vertical field current and the plasma temperature. The figure of merit chosen minimizes the shift of the plasma within the torus and considers position perturbations necessary to maintain the dense and hotter portions of the plasma profile in the center of the torus, i.e., overcome uneven poloidal fields due to the toroidal geometry. The model uses a Kalman filter to estimate unmeasured state variables, and uses the second variation of the calculus of variations to maintain an optimal control path. (Diss. Abstr. Int., B)

2817 EFFECT OF THE FINITE SIZE ELECTRODE ON THE BEAM DIVERGENCE OF AN INTENSE ION SOURCE FOR THE THERMONUCLEAR FUSION RESEARCH. Matsuda, S. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). Jpn. J. Appl. Phys.; 13: No. 10, 1630-1635(Oct 1974).

We describe the beam divergence of the intense ion source with a view toward its application to the neutral beam injection heating of toroidal plasmas in thermonuclear fusion research. In such a system the area of the extraction electrode is, unlike other sources, generally quite large with multi-aperture, and the total beam divergence is determined by a couple of factors, i.e. the divergence of the beam element and the size of the extraction electrode. We discuss the effect of these factors in injecting a larger fraction of the beam into the target without using focusing lens and suggest a direction of improvement for the future injectors. (auth)

2818 F. D. START GAP SWITCHES FOR TPE-1 DEVICE. Sato, Yasuhiro; Takeda, S.; Sugiura, M. (Electrotechnical Lab., Tanashi, Tokyo (Japan). Tanashi Branch). Denshi Gijutsu Sogo Kenkyusho Iho; 38: No. 3-5, 112-123(Jul 1974). (In Japanese).

The development of 40 kV low inductance (40 mH) pressurized field distortion gaps (F. D. gaps) for starting application is described. One unit of trial gap which consists of two main elec-

trodes and one trigger electrode is manufactured first. The physical position of this trigger electrode is changeable. The influence of trigger electrode arrangement on the breakdown time and jitter is investigated. On the basis of experimental results, 68 units of starting gaps are manufactured. By parallel operation of the gaps it has been confirmed that the performance of the gaps is satisfactory. The gaps are in use in operating the TPE-1 devices. (auth)

2819 SUPPRESSION OF TRANSIENT VOLTAGE IN TPE-1 APPARATUS. Takeda, S.; Sato, Y.; Sugiura, M. (Electrotechnical Lab., Tanashi, Tokyo (Japan). Tanashi Branch). Denshi Gijutsu Sogo Kenkyusho Iho; 38: No. 3-5, 124-146(Jul 1974). (In Japanese).

The coil assembly of TPE-1 apparatus consists of two coil systems named Z and θ respectively. Bias, preheating and compression banks are connected in parallel to the θ coil system through the load cables, while the Z system has one capacitor bank. The insulation of each coil system withstands a voltage of about 40 kV. When the capacitor banks are switched on, the voltage appearing in the coil systems rises to be higher than the charging voltage of capacitor banks owing to the multi-reflection of travelling voltage wave at both ends of the cables, which possibly leads to damage of the coil systems. An artificial circuit, simple and inexpensive, is constructed to estimate the nature and magnitude of the transient voltage. The circuit is operated at 30 V and in the real time scale. The maximum amplitude of the transient voltage in the coil systems estimated with the circuit is 1.6 times the amplitude of the charging voltage. The suppression effects of the termination of various L, C, and R combinations on the transient voltages in the coil systems are measured. On the basis of the results of measurements, a suppression equipment is designed and applied to the TPE-1 apparatus. The equipment has successfully suppressed the transient voltages under the insulation strength of the coil assembly. (auth)

2820 MAGNETIC FIELD DISTURBANCE BY DEFORMING METAL SHELLS. Yahagi, E. (Electrotechnical Lab., Tanashi, Tokyo (Japan). Tanashi Branch). Denshi Gijutsu Sogo Kenkyusho Iho; 38: No. 3-5, 147-155(Jul 1974). (In Japanese).

The analytical and experimental studies of the effects of deformed cylindrical metal shells on the magnetic field disturbance are reported. It is assumed that both the metal shells and plasmas have the shape of linear cylinders and that the plasmas have sharp boundaries surrounded by vacuum. First, the axial magnetic fields in the metal cylinder with a slit along the axis are treated analytically, and it has been proved that the slit has a negligibly small effect on the magnetic field. Second, the effects of plasma drift on circular magnetic fields in the cylindrical metal shell are treated analytically, and the effects are clarified by using simple expressions. Third, the effects of plasma drift on circular magnetic fields in the metal cylinder, which has partially different radius and some deformations for plasma diagnostics, are experimentally studied. (auth)

2821 CROSS SECTION CALCULATION RELEVANT TO FUSION REACTOR FIRST WALL MATERIALS, (2). (n, p) and (n, α)-Reactions for V, Nb and Mo. Ohta, M.; Nakashima, H. (Kyushu Univ., Fukuoka (Japan). Faculty of Engineering). Kyushu Daigaku Kogaku Shuho; 47: No. 5, 585-591(Oct 1974). (In Japanese).

For the estimation of radiation damage of the first wall of fusion reactors due to fast neutron bombardment, the cross sections of (n, p) and (n, α) reactions were calculated by using statistical theory. The cross section of inverse compound nucleus formation of neutrons and protons was calculated by using ELIESE-2 code. The applicability of the formula used according to statistical theory was checked by the following reactions, ^{89}Y (n, p), ^{89}Y (n, α), ^{90}Zr (n, p), ^{92}Zr (n, α), ^{94}Zr (n, α), and ^{93}Nb (n, α), and it was found that the formula was not able to reproduce the experimental data. Therefore the calculated values were normalized to the data at 14 MeV for the (n, α) reaction and at 14.5 MeV for the (n, p) reaction. When experimental values could not be obtained, the data were estimated according to the systematic formulas by Garduer and Bayhurst. Calculation was made for ^{92}Mo, ^{94}Mo, ^{95}Mo, ^{96}Mo, ^{97}Mo, ^{98}Mo, ^{100}Mo, ^{93}Nb and ^{51}V. The cross-section for natural molybdenum was composed from these results, and shown in figures together with the cross-sections of Nb and V. Effects on the wall due to the (mp) and (n, α) reactions are finally discussed. (Kato, T.)

2822 CROSS SECTION CALCULATION RELEVANT TO FUSION REACTOR FIRST WALL MATERIALS, (3). (n, p) and (n, α) Reactions for Zr. Ohta, M.; Nakashima, H. Kyushu Univ., Fukuoka (Japan). Faculty of Engineering). Kyushu Daigaku Kogaku Shuho; 47: No. 5, 593-598(Oct 1974). (In Japanese).

In a previous paper, the cross sections of (n, p) and (n, α) reactions for V, Nb, Mo — materials for fusion reactor first wall — were estimated, and the production quantities of hydrogen and helium were estimated roughly. But the production quantities are insufficient regarding the following two points, that is to say, they were not calculated on the basis of the reaction rates by solving transport equations, and they did not take the contribution of reaction products from various reaction processes into consideration. The estimate of the contribution of reaction products requires the reaction cross sections of (n, p) and (n, α) reactions for those reaction products. In this paper, the estimate calculation of the cross sections of (n, p) and (n, α) reactions for ^{90}Zr, ^{91}Zr, ^{92}Zr and ^{94}Zr is reported. These nuclides are generated from Nb and Mo by (n, α), (n, p), (n, d) and (n, 2n) reactions. The cross sections of (n, p) reaction was calculated by Gardner's formula, and that of (n, α) reaction by Bayhurst's formula. The calculation results show that Bayhurst's formula is not sufficient to express the individual characters of nuclides. The cross section of (n, p) reaction for ^{92}Zr at 14 MeV is about $\frac{2}{3}$ of that for ^{93}Nb. The cross section of (n, α) reaction for ^{92}Zr is almost same as that for ^{93}Nb. These results and the fact that the neutron spectrum in a fusion reactor shows a peak at 14 MeV may conclude that in a fusion reactor with the first wall of Nb, nearly 15 percent of hydrogen and helium is generated from converted Zr at the end of durable period of 20 years. (Tai, I)

2823 TOROIDAL COIL. Hashimoto, H.; Hagiwara, K.; Kasahara, T.; Otsu, H. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1973-26719/B/. 20 Mar 1970. 4p. (In Japanese).

A toroidal coil is devised, which may be readily assembled and disassembled with low resistance at contact points. The toroidal coil comprises a cylindrical portion placed through the center of a plasma confining torus which is encased in a plurality of semi-rectangular frames. The semi-rectangular frames and the cylindrical portion are composed of dielectric plates and conducting plate which are alternatively laminated. The end of the frames are firmly connected to the cylindrical portion by volts. (JA)

2824 FEED SYSTEM OF NUCLEAR FUSION APPARATUS. Sato, Katsutoshi; Wase, K. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1973-33319/B/. 19 Jun 1970. 3p. (In Japanese).

The feed system of a nuclear fusion apparatus feeds a current from the exterior of a vacuum vessel to a coil which is disposed within the vacuum vessel and which is formed by winding a hollow conductor. In a feed system according to this invention, an inner conductor and an outer conductor which are hollow are arranged coaxially. The conductors are integrally joined by injecting varnish into the interspace between both the conductors. At branch parts of the conductors located on the coil side, the insulating varnish is injected inside an insulating coating, and one end of each of the conductors is connected to the coil. The current flows from the inner conductor through the coil to the outer conductor. A cooling medium is circulated through the hollow portions of the conductors and the hollow portion of the coil. The feed system possesses favorable cooling effects and plasma containment properties. (JA)

2825 PROBLEMS AND PROMISES OF CONTROLLED FUSION POWER. Mills, R. G. (Princeton Univ., NJ). Mech. Eng.; 97: No. 9, 20-25(Sep 1975).

A general review of controlled fusion research is given. Some of the technical details of a power producing plant are discussed. Some fuel cycles and their advantages are described. (MOW)

2826 LOW-Z ABLATOR TARGETS FOR ELECTRON BEAM FUSION. Sweeney, M.A.; Clauser, M.J. (Plasma Theory Division-5241, Sandia Laboratories, Albuquerque, New Mexico 87115). Appl. Phys. Lett. 27: No. 9, 483-486 (1 Nov 1975).

We have calculated the behavior of composite-shell DT-filled targets irradiated by constant-power ("unshaped") 1-MeV electron beam pulses. The outer part of the shell (the "ablator") is composed of a lower-Z metal than the high-density inner part (the "pusher"). The lower-Z ablator decreases the bremsstrahlung heating of the pusher. The resulting colder and denser pusher is more effective. Breakeven requires about 360 TW deposited for 8 ns in a target about 3 mm in diameter. This is less than half the power required for targets composed of a single high-density metal shell filled with DT. (auth)

2827 GENERALIZED CRITERION FOR FEASIBILITY OF D-T PLASMA FUSION. Treglio, J.R. (Stevens Institute of Technology, Hoboken, New Jersey 07030). J. Appl. Phys. 46: No. 10, 4344-4348 (Oct 1975).

A general criterion for a D-T-fueled plasma is derived. Calculations based on specific assumptions that are not necessarily applicable to all systems yield $n\tau$ values around 10^{15} sec/cm^3 at temperatures near 60 keV, as compared to 5×10^{13} sec/cm^3 at 30 keV obtained by Lawson. Moreover, $n\tau$ is not density independent, improving as the density increases. Additional conditions for controlled fusion indicated are a

minimum heating efficiency of 2% and a minimum confinement efficiency of 99%. (auth)

Wave Phenomena

2828 (LRP-95/75) EMISSION OF LONGITUDINAL WAVES FROM THE INTERACTION OF TWO BEAMS OF TRANSVERSE RADIATION. Weibel, E. S. (Ecole Polytechnique Federale, Lausanne (Switzerland)). Aug 1975. 21p. Dep. NTIS (US Sales Only) $4.50.

When two beams of electromagnetic radiation having finite diameter intersect within a plasma they generate in the interaction volume a second order charge density which is proportional to the amplitudes of both beams. Provided that a resonance condition is satisfied this charge density acts as directional antenna emitting longitudinal waves. In this process power is transferred from the beam of higher frequency to the beam of lower frequency with the excess going into the longitudinal waves. The power emitted is $P = P_1P_2/P^*$ where P_i are the powers of the electromagnetic beams. P^* is computed for both Langmuir and sound waves. In the first case this process can probably be used as a means to measure the plasma density locally. (auth)

2829 (N-75-16348) COMPUTATIONAL STUDY OF NONLINEAR PLASMA WAVES. I. Simulation Model and Monochromatic Wave Propagation. Matda, Y.; Crawford, F. W. (Stanford Univ., Calif. (USA). Inst. for Plasma Research). Dec 1974. 40p. (NSF-GP-43703X; NASA-CR-142020; SU-IPR-607). NTIS $3.75.

An economical low noise plasma simulation model is applied to a series of problems associated with electrostatic wave propagation in a one-dimensional, collisionless, Maxwellian plasma, in the absence of magnetic field. The model is described and tested, first in the absence of an applied signal, and then with a small amplitude perturbation, to establish the low noise features and to verify the theoretical linear dispersion relation at wave energy levels as low as 0.000,001 of the plasma thermal energy. The method is then used to study propagation of an essentially monochromatic plane wave. Results on amplitude oscillation and nonlinear frequency shift are compared with available theories. The additional phenomena of sideband instability and satellite growth, stimulated by large amplitude wave propagation and the resulting particle trapping, are described. (auth)

2830 AMPLIFICATION OF EXTRAORDINARY WAVES THROUGH RELATIVISTIC MAGNETIZED PLASMA. Kubo, H.; Nakamura, S.; Yuyama, T.; Mitani, K. (Physics Laboratory, College of General Education, Kyoto University, Kyoto, Japan); Aihara, S.; Hosokawa, M.; Ikegami, H. Phys. Rev. Lett. 35: No. 15, 998-1000 (13 Oct 1975).

We observe amplification of extraordinary waves which is interpreted as negative absorption of the relativistic magnetized plasma confined in a mirror machine. Experimental results are explained well by the relativistic kinetic theory with the assumption of an isotropic peaked distribution, $f(p) \propto p^l \exp(-\epsilon/T)$. (auth)

2831 NONLINEAR OPTICAL STANDING WAVES IN OVERDENSE PLASMAS. Marburger, J.H.; Tooper, R.F. (University of Southern California, Los Angeles, California 90007). Phys. Rev. Lett. 35: No. 15, 1001-1004 (13 Oct 1975).

A new class of exact standing-wave solutions of the Maxwell cold-plasma equations with fixed ions is described. The waves are transverse, and circularly polarized. These solutions permit an analytical treatment of intense wave penetration into inhomogeneous plasmas with fixed ions. (auth)

2832 RADIATION CHARACTERISTICS OF ION WAVES IN A WEAKLY MAGNETIZED PLASMA. Ohnuma, T.; Izawa, H.; Adachi, S. (Department of Electrical Engineering, Tohoku University, Sendai, Japan). Phys. Rev. A 12: No. 4, 1648-1652 (Oct 1975).

The phase velocity and wave amplitude of ion waves launched by a small probe are investigated experimentally and theoretically for all directions in a weakly magnetized plasma. Ion waves in a weakly magnetized plasma are found to propagate omnidirectionally (excluding the effect of plasma flows) with respect to the phase velocity and to be launched bidirectionally along the direction of the magnetic field with respect to the amplitude. The excitation mechanism is also investigated in a fluid model in comparison with the results of a nonmagnetized plasma. (auth)

2833 STIMULATED COLLECTIVE SCATTERING FROM A MAGNETIZED RELATIVISTIC ELECTRON BEAM. Sprangle, P.; Granatstein, V.L.; Baker, L. (Naval Research Laboratory, Washington, D.C. 20375). Phys. Rev. A 12: No. 4, 1697-1701 (Oct 1975).

We analyze stimulated scattering of a right-circularly-polarized electromagnetic pump wave, of frequency ω_0, from a cold relativistic magnetized electron beam. The pump wave is chosen to satisfy the dispersion relation associated with the magnetized beam. The scattered waves consist of collective plasma oscillations as well as right- and left-polarized electromagnetic waves, traveling parallel and antiparallel to the beam. The frequency of the forward-scattered electromagnetic wave is Doppler shifted up twice and is of order $\gamma_{0z}^2\omega_0$, where $\gamma_{0z} = (1-v_0^2/c^2)^{-1/2}$ and v_0 is the beam's speed. Enhanced stimulated scattering results if the frequency of the pump, in the beam frame, is approximately equal to the electron's cyclotron frequency. Enhanced growth rates for the scattering process are obtained for the scattered radiation. This theory describes a mechaniam which is a plausible explanation of a recent experiment in which ~100 kW of submillimeter radiation was observed. In view of the large up-conversion in frequency and enhanced growth rates of the scattered radiation, a new high-frequency generative device based on this mechanism seems possible. (auth)

2834 FINITE-AMPLITUDE IONIZATION WAVES IN A PARTLY IONIZED PLASMA. Sinkevich, O.A. (Moscow Power Institute). High Temp. 13: No. 1, 43-49 (Sept 1975).

A nonlinear solution is constructed for the state at which a developed ionization instability can arrive in a partly ionized plasma in a magnetic field. It is shown that when allowance is made for the electron thermal conductivity and a larger-than-critical Hall parameter, periodic oscillations with finite amplitude can arise is such a plasma. Besides the periodic solutions, one can also have solutions of the type of isolated waves and ionization and recombination waves. (auth)

2835 SURFACE WAVES ON THE BOUNDARY OF A MAGNETIZED PLASMA. Uberoi, C.; Rao, U. J. (Indian Inst. of Science, Bangalore). Plasma Phys.; 17: No. 9, 659-670(Sep 1975).

Full dispersion curves including the effect of ions are presented for the electromagnetic surface waves propagating over a plasma-plasma interface in the direction perpendicular to the magnetic field which is parallel to the interface. The effect of ions and finite density ratio of the two media at the boundary give rise to various new features in the dispersion characteristics of these surface waves. (auth)

2836 NEW TYPE OF COHERENT OSCILLATIONS IN A RELATIVISTIC ELECTRON PLASMA. Kjellmert, B. (Inst. of Tech., Uppsala). Plasma Phys.; 17: No. 9, 649-658(Sep 1975).

A new type of one-dimensional coherent oscillation is described which may occur when strong electromagnetic fields interact with a cold collision-less electron plasma. Here the electron density varies in a direction perpendicular to the magnetic field; the electric field has longitudinal and transverse components. The governing system of partial differential equations is reduced to a system of ordinary differential equations by means of two fundamental assumptions: (1) fields and electron momenta vary in a coherent way; (2) the electron density is inversely proportional to the Lorentz contraction factor. It is shown analytically that very strong transverse fields appear when the generalized phase velocity equals c, and that the oscillations are plasma oscillations in the small-amplitude nonrelativistic limit. The system of ordinary differential equations is also numerically studied. Examples of periodic, near-periodic, and non-periodic solutions are given. In a near-periodic situation the magnetic field is virtually constant for almost all time-periods. The non-periodic solution approaches a steady state where electrons are streaming in crossed electric and magnetic fields. (auth)

2837 COMPARISON BETWEEN LONGITUDINAL WAVE IN ELECTRON PLASMA AND ONE-VELOCITY NEUTRON TRANSPORT. Hno, Tomoaki (Hitachi Ltd., Kawasaki, Kanagawa (Japan). Atomic Energy Research Lab.); Ozawa, Y. J. Nucl. Sci. Technol. (Tokyo); 12: No. 2, 107-114(Feb 1975).

A comparison is made between the longitudinal wave in an electron plasma and the one-velocity neutron transport, using the Neumann series solution of the linearized Boltzmann equation. As a result, the transport of the disturbance in an electron plasma and the neutron transport are both expressed by the superposition of essential modes, which describe the streaming processes of electrons and neutrons. The spatio-time distribution of the essential mode in a neutron field is always positive, while, that in an electron plasma is negative. This difference explains why the asymptotic mode of neutrons exhibits the diffusion-like behavior and that of electrons plasma oscillation. (auth)

2838 ION-ACOUSTIC SOLITARY WAVES IN MULTICOMPONENT PLASMAS WITH NEGATIVE IONS. Das, G. C. (Indian Inst. of Science, Bangalore). IEEE (Inst. Electr. Electron. Eng.) Trans. Plasma Sci.; PS-3: No. 3, 168-173(Sep 1975).

By using the perturbation technique, a Korteweg-de-Vries (K-dV) equation for a multicomponent plasma with negative ions and isothermal electrons was derived. The stationary solutions of K-dV equation are described and it is shown that in the presence of

multiple ions, the amplitude of solitons exhibits interesting behavior, especially when the negative ions are present. (auth)

2839 ELECTROMAGNETIC WAVE PROPAGATION IN A MAGNETOPLASMA FILLED COAXIAL STRUCTURE. I. Theoretical. Askins, H. W. Jr.; Miller, D. B. (Purdue Univ., Lafayette, IN). IEEE Trans. Plasma Sci.; PS-3: No. 3, 102-111 (Sep 1975).

This study is concerned with the problem of electromagnetic wave propagation in a magneto-plasma filled coaxial structure. The problem is formulated using the classical boundary value problem approach. Based on this formulation an extensive numerical investigation is performed. The numerical investigation shows the existence of propagating slow modes, backward modes, a quasi-TEM mode, and waveguide-type modes in a magneto-plasma filled coaxial structure. Dispersion curves for these different modes are presented. The dependence of the different modes on various plasma parameters is considered. (auth)

2840 ELECTROMAGNETIC WAVE PROPAGATION IN A MAGNETO-PLASMA FILLED COAXIAL STRUCTURE. II. Experimental. Miller, D. B.; Askins, H. W. Jr. (Purdue Univ., Lafayette, IN). IEEE Trans. Plasma Sci.; PS-3: No. 3, 112-115 (Sep 1975).

Measurements were made of electromagnetic propagation in a coaxial electrode structure filled with longitudinally magnetized plasma. The annular plasma region had a 9.55 cm outer diameter, a 3.82 cm inner diameter and was approximately 60 cm long. A magnetic field of 300 gauss was employed. Electromagnetic wave frequencies were in the range 0.5 to 2.4 GHz. The plasma was generated by a continuous glow discharge. The resulting omega vs. beta curves closely follow the predicted curves for the "quasi-TEM" mode. On the basis of this model, plasma frequencies were 40–80 percent of the cyclotron frequency, depending on magnitude of the glow discharge current. (auth)

2841 EXAMINATION OF CLASSICAL COUPLING OF LASER LIGHT TO THIN, DENSE PLASMA LAYERS. Osborn, R. K. (Univ. of Michigan, Ann Arbor). IEEE Trans. Plasma Sci.; PS-3: No. 3, 116-121(Sep 1975).

Classical absorption, i.e., inverse bremsstrahlung, is examined in the context of two different models of the radiation field and the plasma. One model is developed by approximations starting from Maxwell's equations plus a hydrodynamic description of the plasma. The other is based upon a model of photon transport. It is shown that the laser-plasma coupling implied by these models appears (at least qualitatively) to be quite different. According to the Maxwell-hydrodynamic model, thin but dense plasma layers are strongly reflecting whereas the photon transport model seems to imply that they are strongly absorptive. This discrepancy is not a paradox but a consequence of different kinds of approximations implicit in the two computational approaches. However, it is not clear at this point that this predicted difference in laser-plasma coupling can readily be clarified analytically. (auth)

2842 INSTABILITY OF ELECTROMAGNETIC ION CYCLOTRON HARMONIC WAVES IN PLASMAS. Lee, K. F. (Chinese Univ. of Hong Kong). IEEE Trans. Plasma Sci.; PS-3: No. 3, 122-125(Sep 1975).

The stability of electromagnetic ion cyclotron harmonic waves propagating normal to an external magnetic field is studied for plasmas whose ions possess loss cone type velocity distributions. It is found that, if the ions are stationary, no instability develops except in the extreme case when the ratio of parallel to perpendicular "temperatures" of the ions is of the order m/sub i// m/sub e/, where m/sub i/ and m/sub e/ are the ion and electron masses respectively. However, for the case of two counter-streaming ion beams in a neutralizing background of electrons, instability at zero frequency and near the first several ion cyclotron harmonics can occur if the streaming velocity is of the order of the electron thermal speed. (auth)

2843 NONLINEAR FILAMENTATION OF LOWER-HYBRID CONES. Morales, G.J.; Lee, Y.C. (Department of Physics, University of California, Los Angeles, California 90024). Phys. Rev. Lett. 35: No. 14, 930-933 (6 Oct 1975).

The nonlinear distortion of the propagation cones of lower-hybrid waves is shown to be governed by the modified Korteweg-de Vries equation. Since such an equation admits exact solutions of the multiple-soliton form, it is predicted that filamented cones should be formed when large-amplitude lower-hybrid waves are excited in a plasma. (auth)

2844 PROPAGATION OF LOCALIZED ELECTROMAGNETIC PULSES IN PLASMAS. Gersten, J.I.; Tzoar, N. (Department of Physics, City College of the City University of New York, New York, New York 10031). Phys. Rev. Lett. 35: No. 14, 934-937 (6 Oct 1975).

We study the propagation of three-dimensional, localized, transverse, circularly polarized pulses of electromagnetic radiation in ionized matter. Soliton propagation both below and above the plasma frequency can occur. A critical energy for the formation of solitons exists. The solitons can exist with states of internal excitation. (auth)

2845 STRONG-TURBULENCE THEORY AND THE TRANSITION FROM LANDAU TO COLLISIONAL DAMPING. Dum, C.T. (Max-Planck-Institut für Plasmaphysik, 8046 Garching bei München, Germany). Phys. Rev. Lett. 35: No. 14, 947-950 (6 Oct 1975).

New methods are introduced for a quantitative evaluation of the dielectric constant describing the interaction of a long-wavelength test wave with electrons in the presence of electron-ion collisions or small-scale turbulence. It is shown that the usual resonance-broadening arguments of strong-turbulence theory do not apply. (auth)

2846 ESTIMATION OF FREQUENCY SHIFT OF AN ION SOUND WAVE PARAMETRICALLY EXCITED IN TONKS-DATTNER RESONANCE. Ikezawa, S. (Department of Electronic Engineering, Chubu Institute of Technology, Kasugai, Japan); Okuda, T. J. Appl. Phys. 46: No. 10, 4606-4607 (Oct 1975).

It is shown that the frequency shift of the excited ion sound wave in Tonks-Dattner resonance is due to the nonlinear phenomenon represented by the frequency-mismatched factor of the nearly free resonance parametric theory derived by Nishikawa. It is also shown that the increase of the electron temperature is negligibly small so that the effect of the increase of the electron temperature on the shift can be neglected. (auth)

2847 EXPERIMENTAL STUDY OF PROPAGATION OF ELECTROSTATIC ION WAVES IN A MAGNETIC FIELD. Lee, A.; Oleson, N.L.; Jones, W.D. (Department of Physics, University of South Florida, Tampa, Florida 33620). J. Appl. Phys. 46: No. 10, 4609-4611 (Oct 1975).

The results of an experimental investigation of electrostatic ion waves in an rf-generated argon plasma supported by a longitudinal magnetic field is presented. For off-axis wave propagation, observations agree quite well with the theoretical predictions of Joyce and Dory. Observations for parallel propagation, however, yield a dispersion curve exhibiting structure not predicted by linear theory. (auth)

2848 AMPLIFICATION OF ELECTROMAGNETIC WAVES IN A MAGNETICALLY ACTIVE PLASMA WITH A NONISOTROPIC ELECTRON VELOCITY DISTRIBUTION. Karapetyan, R.V.; Fedorov, M.V. (P. N. Lebedev Physics Institute, Moscow). Sov. J. Quantum Electron. 5: No. 4, 397-400 (Apr 1975).

A theoretical analysis is made of the stimulated bremsstrahlung absorption and "emission" (negative absorption) in the presence of a static homogeneous magnetic field. It is shown that collisions can result in an effective resonant amplification of electromagnetic waves in a magnetically active plasma if the average transverse electron energy is more than twice as large as the energy of electron motion along the magnetic field. Some specific cases of negative absorption under these conditions are considered. (auth)

ENGINEERING

Energy Conversion

2849 (TID--24922) SNAP 29 POWER SUPPLY SYSTEM. Ninth Quarterly Progress Report. (Isotopes, Inc., Middle River, Md. (USA). Nuclear Systems Div.). Jan 1969. Contract AT(29-2)-2062. 336p. Dep. NTIS $11.00.

Declassified 2 Nov 1971.

Progress during the period from Oct. through December 1968 in the development of the SNAP 29 battery, a radioisotope-fueled thermoelectric generator (RTG) system for spacecraft power supplies, is reported. Information is included on: fabrication and testing of RTG components; systems evaluation and integration; reliability analysis and prediction; reentry trajectory and heating rates for various burn-up element configurations; and system safety evaluation. (LCL)

Facilities and Equipment

Refer also to abstracts 3942, 3944, 3945, and 4885.

2850 MANUFACTURING METHOD OF FILAMENTS. Shindo, T.; Nakajima, M. (to Nihon Denshi Kogyo Co. Ltd., Mitaka, Tokyo (Japan)). Japanese Patent 1973-19498/B/. 24 Dec 1969. 2p. (In Japanese)

A method was developed for manufacturing filaments used as electron sources in electron microscopes and in electron beam machining apparatus. The conventional filament is the hair-pin type, made by bending only one wire material. Such a filament forms an elliptic source of electron beams and generates astigmatism when the beam is converged by a magnetic lens. In the new method, two filament materials, such as tungsten or tantalum wire, are put together in a V-shape, and the connection point is heated and fused by an electron or ion beam. The fused portion rounds into a sphere due to the surface tension, and an ideal spherical beam source can be formed. A second procedure, for manufacturing a point source of electron beams, is the same as the preceding one, except that the particle beam is slowly and gradually weakened. A projection is formed on the tip of the rounded V-shaped filament, resulting in an ideal point source of electron beams. (JA)

2851 CIRCULATING EQUIPMENT FOR RADIOACTIVE LIQUID. Ueda, Kazunari; Hirasawa, Y.; Shirataki, K. (to Mitsubishi Atomic Power Industries, Inc., Tokyo (Japan)). Japanese Patent 1974-15879/B/. 6 Jan 1969. 3p. (In Japanese)

In a circulating system for a radioactive liquid, it is necessary to individually lay a shielding material on a heat exchanger, storage tank, and piping. The shielding material is complicated in its arrangement and large amounts are required. In circulating equipment the heat exchanger is disposed in the tank under an immersed state and the tank is formed into a multiple tank, so that the radioactive liquid subjected to the heat exchange flows out and circulates successively from an inner tank to an outer tank. Radiation from the heat exchanger situated innermost is shielded by the liquid flowing in the inner tank, radiation from the inner tank is shielded by the liquid flowing in an intermediate tank, radiation from the intermediate tank is shielded by the liquid flowing in the outer tank, radiation from the outer tank is shielded by a shielding material surrounding this tank. Accordingly, the shielding material may be thin and can be simply mounted. (JA)

Lasers

2852 (CONF-720133--4, pp 51-65) MODE COUPLING IN LASERS. Ripper Filho, J. E. (Univ. Estadual de Campinas, Sao Paulo, Brazil). 1972. (In Portuguese).

From 4th symposium on theoretical physics; Rio de Janeiro, Brazil (4 Jan 1972).

In IV Brazilian symposium on theoretical physics. Volume XI.

A review is given of the different forms in which modes can be coupled. One-cavity modes, first order locking modes, and second order locking modes are considered. (JSR)

2853 (LA-UR-1832) PULSE FORMING NETWORKS FOR FAST PUMPING OF HIGH POWER ELECTRON-BEAM-CONTROLLED CO_2 LASERS. Riepe, K. B. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-eng-36. 10p. (CONF-751102-1). Dep. NTIS $4.00.

From international laser exposition and electro-optics '75; Anaheim, California, USA (11 Nov 1975).

The transverse electric discharge is a widely used technique for pumping CO_2 lasers at high pressures for the generation, simply and efficiently, of very high power laser pulses. The development of the electron-beam-controlled discharge has allowed the application of the transverse discharge to large aperture, very high energy systems. LASL is now in the process of assembly and checkout of a CO_2 laser which is designed to generate a one nanosecond pulse containing 10 kilojoules, for use in laser fusion experiments. The front end of this laser consists of a set of preamplifiers and a mode locked oscillator with electro-optic single pulse switchout. The final amplifier stage consists of four parallel modules, each one consisting of a two-sided electron gun, and two 35 x 35 x 200 cm gas pumping regions operating at a pressure of 1800 torr with a $3/1\frac{1}{4}/1$ ($He/N_2/CO_2$) laser mix. (auth)

2854 (SAND-75-5629) PULSE POWER TECHNOLOGY APPLICATION TO LASERS. Prestwich, K. R. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1975. 23p. (CONF-751102-3). Dep. NTIS $4.50.

From international laser exposition and electrooptics '75; Anaheim, California, USA (11 Nov 1975).

Recent developments of intense relativistic electron beam accelerators and the associated pulse power technology are reviewed. The design of specific accelerators for gas laser excitation sources is discussed. A 3 MV, 800 kA, 24 ns electron beam accelerator under development for the electron beam fusion program is described along with the low jitter multichannel oil-dielectric rail switches developed for this application. This technology leads to the design of a 20 kJ, short pulse accelerator optimized gas laser excitation with radially converging electron beams. Other gas laser research requirements have led to the development of an accelerator that will produce a 0.5 MV, 20 kJ, 1 mu s electron beam pulse. (auth)

2855 (UCID-16925) EFFECT OF OPTICAL SYSTEMS ON DIFFRACTION. Weaver, H. J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Jul 1973. Contract W-7405-Eng-48. 16p. Dep. NTIS $4.00.

A relationship (isomorphism) that exists between coherent optical systems with and without lenses is described. This relationship turns out to be very simple and very useful for the design and analysis of laser optical systems. The isomorphism is derived by Fourier analyses. A study of various optical configurations is presented and several examples are given. (auth)

2856 (UCID-16926) BEAM SHAPING AND PROPAGATION STUDY FOR THE KILOJOULE LASER SYSTEM. Weaver, H. J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1973. Contract W-7405-Eng-48. 36p. Dep. NTIS $5.00.

The radial energy density profile of a laser beam that is to be injected into the kilojoule laser system must be such that diffraction effects, which may lead to self-focusing, are minimized while at the same time energy extraction is maximized. Although the two effects are interrelated they are discussed separately for the sake of clarity. (auth)

2857 (UCID-16930) FLOWING DYE CELL AND PUMP SYSTEM FOR MODE-LOCKED OSCILLATOR. Pierce, E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 May 1972. 11p. Dep. NTIS $4.00.

A description of a small, inexpensive pump system and flowing dye cell for use in a mode-locked laser oscillator is given. (auth)

2858 (UCID-16935) KINETIC MODELING OF PHOTODISSOCIATION IODINE LASER AMPLIFIERS. Turner, C. E. Jr.; Rapagnani, N. L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Oct 1974. Contract W-7405-Eng-48. 26p. (CONF-7210134-1). Dep. NTIS $5.00.

A comprehensive kinetic model is described which predicts the time dependence of the inversion in iodine-laser energy-storage amplifiers over a wide range of helium diluent pressure. The high rare gas pressures (1-10 atm), which are required to suppress superfluorescence and produce bandwidths suitable for short generation via collision broadening, significantly modify the chemical kinetics of the flash photolysis of fluorinated alkyl iodides (RI, e.g., CF_3I, C_3F_7I) because of lower temperature rise, fast thermalization of "hot" radicals and three-body effects. The model includes many of the typical two-body deactivation, recombination and reaction mechanisms previously considered for low pressure analyses but it is appropriate to omit some uncertain reactions involving "hot" radicals. In addition, it is necessary to consider I_2 formation via three-body iodine atom

recombination: (a) I + I + M, (b) I* + I + M, and (c) I* + I* + M, where the main catalysts (M) are He, I_2 and RI. (auth)

2859 (UCRL-77480) MECHANICAL DESIGN, MATERIALS SELECTION, FABRICATION AND ASSEMBLY OF ULTRACLEAN, HIGH-GAIN, Nd: GLASS DISK LASER AMPLIFIERS. Fountain, W. D.; Ker, K.; Holl, P.; Bubp, D.; Neef, W. S., Jr. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 Nov 1975. Contract W-7405-Eng-48. 7p. Dep. NTIS $4.50.

Particulate contamination in disk amplifiers with high flashlamp fluxes (which can generate particles) causes three types of laser beam obscuration, which cause small-scale self-focusing. Methods for obtaining disk amplifiers that stay clean are described. (auth)

2860 (UCRL-Trans-10946) PRESSURE BROADENING OF THE 1.3 mu m IODINE LASER LINE. Fuss, W.; Hohla, K. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (F. R. Germany)). Dec. 1974. Translation of IPP-IV/67. 43p. Dep. NTIS $5.00.

Storable energy of a high energy laser is inversely proportional to its stimulated emission cross-section sigma. By adding a foreign gas, the emission line is broadened and sigma is thereby lowered. The sigma of the iodine laser as a function of pressure of several gases (Ar, N_2, CO, CO_2, SF_6, CF_3Br, C_3F_7J, CF_2Cl_2 $(CF_3)_2CO$) by an absolute and a relative method, 1/sigma is a linear function of pressure in spite of the fact that overlapping of the hyperfine structure components varies considerably in the range investigated. For energy storage, CO_2 is a good compromise between pressure broadening and chemical deactivation of the excited I atoms. At one atmosphere of CO_2, 5 to 7 J cm^{-2} can be stored, hyperfine structure is extensively blurred, and amplification of pulses shorter than 100 psec should be possible. (auth)

2861 TWO STAGE GAS DYNAMIC LASER. Milling, R. W. (to Secretary of the Air Force). US Patent 3,900,802. 19 Aug 1975. Filed Date 8 Jun 1973. 4p.

A gas dynamic laser having high temperature high pressure gas produced from combustion is expanded in a first nozzle to provide a population inversion in a first cavity from which laser energy is extracted. The gas is then passed through oblique shocks to compress the gas slightly after which heat is added to obtain major compression. The gas is then expanded in a second nozzle structure to provide a population inversion in a second cavity from which laser energy is extracted. The gas is again passed through oblique shocks to decelerate the flow slightly after which the gas is passed through a subsonic diffuser for release to the atmosphere. (auth)

2862 BROAD BAND EXCIPLEX DYE LASERS. Dienes, A.; Shank, C. V.; Trozzolo, A. M. (to Bell Telephone Labs., Inc.). US Patent 3,906,399. 16 Sep 1975. Filed Date 9 Nov 1972. 8p.

The disclosure is concerned with exciplex dye lasers, i.e., lasers in which the emitting species is a complex formed only from a constituent in an electronically excited state. Noting that an exciplex laser, favorable from the standpoint of broad tunability, results from a broad shift in the peak emission wavelength for the exciplex relative to the unreacted species, a desirable class resulting in such broad shift is described. Preferred classes of laser media utilizing specified resonant molecules are set forth. (auth)

2863 INERT GAS METALLIC VAPOR LASER. Low, G. M.; Russell, G. R.; Nerheim, N. M.; Pivirotto, T. J. US Patent 3,906,398. 16 Sep 1975. Filed Date 3 Dec 1973. 10p.

An inert gas-copper vapor laser is described consisting of a multichamber structure, wherein inert gases are heated, mixed with copper powder which is then vaporized, thereby establishing an inert gas-copper vapor mixture, in a plenum chamber. The inert gas copper vapor mixture, hereinafter referred to as the lasant, passes from the plenum chamber through a nozzle into a laser chamber, wherein it flows a lasant stream of a desired velocity; positioned in the laser chamber are a pair of spaced apart mirrors and a pair of spaced apart electrodes which together form a cylindrical laser cavity through which the lasant flows. One or both electrodes are comb-shaped. Each comb-shaped electrode consists of a plurality of equal length wires, all of which are connected together at a common terminal. The ends of the wires, opposite the ends which are connected together at the common terminal, define tips which are equally spaced apart in a direction parallel to the cavity axis and are equally spaced therefrom. Current discharge due to a current pulse applied to the electrodes takes place at the wires' tips. Each electrode is protected by a boron nitride electrode protective member which is slotted so that only the tips of the wires are exposed to the opposite electrode and to the hot plasma flowing between the electrodes through the laser cavity. (auth)

2864 DIATOMIC INFRARED GASDYNAMIC LASER. McKenzie, R. L. (to National Aeronautics and Space Administration). US Patent 3,906,397. 16 Sep 1975. Filed Date 26 Apr 1971. 6p.

A gasdynamic laser is provided utilizing the infrared vibration-rotation transitions of a diatomic gas such as carbon monoxide. (auth)

2865 GLASS LASER DISCS WITH ANNULAR ALKALI LEAD BORATE COATINGS AND USE THEREOF. Cooley, R. F. (to Owens-Illinois, Inc.). US Patent 3,906,396. 16 Sep 1975. Filed Date 15 Oct 1975. 10p.

A laser assembly that includes a novel glass laser disc having an annular alkali lead borate glass coating for use in the assembly is disclosed. The annular coating has an index of refraction that is about 3 to 12 percent greater than the index of refraction of the laser disc, the thermal properties also being sufficiently matched with the glass laser disc so as to prevent the development of undesirable strains therein, the glass coating comprising a mixture of alkali metal oxides in which at least two different alkali metal oxides are present, and any K_2O that is present is limited to an amount of not substantially more than about 1 percent by weight and an effective energy absorbing amount of heavy metal oxide that absorbs energy at a wavelength of about 1.06 microns to prevent parasitic oscillations. The heavy metal oxides include oxides of transition metals of the 3d, 4d, 4f, 5d and 5f orbital series. (auth)

2866 LOW-THRESHOLD ROOM-TEMPERATURE DOUBLE-HETEROSTRUCTURE $GaAs_{1-z}Sb_z/Al_yGa_{1-y}As_{1-z}Sb_z$ INJECTION LASERS AT 1-μm WAVELENGTHS. Nahory, R.E.; Pollack, M.A. (Bell Telephone Laboratories, Holmdel, New Jersey 07733). Appl. Phys. Lett. 27: No. 10, 562-564 (15 Nov 1975).

Double-heterostructure (DH) injection lasers based on the $GaAs_{1-z}Sb_z/Al_yGa_{1-y}As_{1-z}Sb_z$ system have been fabricated using liquid phase epitaxial growth techniques and operated at room temperature at wavelengths in the 1-μm region. The observed room-temperature threshold current densities, as low as 2100 A cm^{-2}, are comparable to those of GaAs/AlGaAs devices of similar geometry. (auth)

2867 LASER ACTION ON THE 342-nm MOLECULAR IODINE BAND. Ewing, J.J.; Brau, C.A. (Avco Everett Research Laboratory, Incorporated, Everett, Massachusetts 02149). Appl. Phys. Lett. 27: No. 10, 557-559 (15 Nov 1975).

A new laser operating on the 342-nm band of I_2 is reported. Electron-beam-excited mixtures of argon with CF_3I and HI produced this I_2 laser. The excited state of this laser is probably formed by ion recombination reactions, and a plausible mechanism is given. (auth)

2868 PULSED CORONA EXCITATION OF HIGH-POWER UV NITROGEN LASERS AT PRESSURES OF 0-3 BAR. von Bergmann, H.M.; Hasson, V.; Preussler, D. (Optics and Spectroscopy Division, NPRL, C.S.I.R., Pretoria 0001, South Africa). Appl. Phys. Lett. 27: No. 10, 553-555 (15 Nov 1975).

Stabilized pulsed corona-type discharges can be used to pump uv laser efficiently at high pressures and on nanosecond time scales. This letter deals with the adaptation of this principle to the excitation of molecular nitrogen lasers at pressures ranging from 0 to 3 bar. Magewatt pulses of nanosecond duration may be obtained from a simple 25-cm atmospheric-pressure device. The electrical excitation is effected by a flat-plate Blumlein circuit. (auth)

2869 HIGH-POWER I_2 LASER IN THE 342-nm BAND SYSTEM. Bradford, R.S. Jr.; Ault, E.R.; Bhaumik, M.L. (Northrop Research and Technology Center, Hawthorne, California 90250). Appl. Phys. Lett. 27: No. 10, 546-548 (15 Nov 1975).

Strong laser emission was observed in the 342-nm I_2 band system from an e-beam-excited mixture of Ar and CF_3I (250 : 1) at a total pressure of 10 atm. Laser emission occurred simultaneously at 342.0, 342.3, 342.4, and 342.8 nm with a peak power of 3.6 MW in a 10-nsec (FWHM) pulse. (auth)

2870 cw CHEMICAL TRANSFER CO_2 LASER. Benard, D.J. (Department of Physics and Quantum Institute, University of California, Santa Barbara, California 93106). Appl. Phys. Lett. 27: No. 10, 542-544 (15 Nov 1975).

The combustion of Mg vapor in N_2O with He and Co_2 diluents in a low-loss coaxial laser cavity has resulted in cw oscillation at 10.6 μm. The performance characteristics of the flame laser in a coaxial geometry were found to differ significantly from those expected on the basis of previous gain measurements taken in a transverse flow configuration. (auth)

2871 EXCITATION OF TRANSVERSELY EXCITED CO_2 WAVEGUIDE LASERS. Wood II, O.R.; Smith, P.W.; Adams, C.R.; Maloney, P.J. (Bell Telephone Laboratories, Holmdel, New Jersey 07733). Appl. Phys. Lett. 27: No. 10, 539-541 (15 Nov 1975).

Using a preionization scheme based on the Malter effect, small-signal gains > 5%/cm at 10.6 μm have been produced in a 1-mm^2-cross-section waveguide CO_2 amplifier at total operating pressures of 100–760 Torr. Comparisons are made between this preionization scheme and those using electron beams. (auth)

2872 INTEGRATED ELECTRO-OPTIC INTRACAVITY FREQUENCY MODULATION OF DOUBLE-HETEROSTRUCTURE INJECTION LASER. Reinhart, F.K.; Logan, R.A. (Bell Laboratories, Murray Hill, New Jersey 07974). Appl. Phys. Lett. 27: No. 10, 532-534 (15 Nov 1975).

Integration of a taper-coupled GaAs-$Al_xGa_{1-x}As$ laser with a linear electro-optic modulator permits efficient optical frequency modulation of the laser emission. The pulsed room-temperature threshold current density of the device was 8 kA/cm². Frequency modulation depth in excess of 15 GHz (corresponding to a wavelength shift of 0.4 Å) was obtained with a reverse bias change of 20 V across the modulator. Conversion of frequency modulation into intensity modulation was demonstrated with a characteristic power P_0 of 10 μW/MHz for 90% intensity modulation. It is shown that reduction of P_0 by an order of magnitude is easily feasible. (auth)

2873 GAS TEMPERATURE IN THE DISCHARGE PLASMA OF A CARBON MONOXIDE LASER. Dorosh, V.S.; Dobro, L.F.; Ivanov, V.N.; Lotkova, E.N.; Pisarenko, V.V. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). Sov. J. Quantum Electron. 5: No. 5, 560-563 (May 1975).

Thermocouple, interferometric, and spectroscopic measurements were made of the gas temperature in the discharge plasma of a CO laser operating at room temperature and using a $CO:N_2:He:Xe:O_2 = 1:5:24:1:0.04$ mixture. The measurements were carried out for different values of the discharge current, gas pressure, and power supply. The experimental data were compared with the results deduced by solving the heat balance equation. (auth)

2874 STIMULATED EMISSION FROM NEODYMIUM-DOPED YTTRIUM ALUMINUM GARNET CRYSTALS PUMPED WITH INJECTION LASERS. Bilak, V.I.; Dokuchaev, N.R.; Onishchenko, A.M.; Pashkov, V.A.; Petrov, A.I.; Stel'makh, M.F.; Chernousov, N.P. Sov. J. Quantum Electron. 5: No. 5, 572-574 (May 1975).

An investigation was made of the operation of a YAG:Nd^{3+} laser excited by pulse-injection semiconductor lasers emitting at wavelengths of 0.81 and 0.88 μ. The flat end of an active rod was pumped. The room-temperature laser thresholds of rods of 1 mm diameter and 20 mm long and of 2 mm diameter and 20 mm long were 1×10^{-4} and 3.7×10^{-4} J, respectively. A study was made of the emission when the rate of pumping was twice the threshold value. The stimulated emission from the Nd^{3+} ions was of spiky nature: The duration of each spike did not exceed 1 μsec and the power carried by a spike could reach 100 mW. (auth)

2875 INFLUENCE OF IMPERFECTIONS IN THE CRYSTAL STRUCTURE OF GALLIUM ARSENIDE ON THE PARAMETERS OF ELECTRON-BEAM EXCITED LASERS. Grigor'ev, O.N.; Gridneva, I.V.; Krasavina, E.M.; Kryukova, I.V.; Chugunova, S.I. (All-Union Scientific-Research Institute of Optophysical Measurements, Moscow). Sov. J. Quantum Electron. 5: No. 5, 577-579 (May 1975).

An investigation was made of the parameters of the radiation emitted by electron-beam-excited lasers made of gallium arsenide single crystals prepared by different methods. A correlation was established between the radiative characteristics of these lasers and the degree of structure imperfection of the crystals, determined by x-ray diffraction methods. The high efficiency and homogeneity of the laser emission from the samples prepared by the Stockbarger method was attributed to a high quality of the structure of crystals produced in this way. (auth)

2876 GAIN OF A CO_2 LASER WITH A DOUBLE TRANSVERSE DISCHARGE AT HIGH INPUT ENERGY DENSITIES. Orishich, A.M.; Ponomarenko, A.G. (Institute of Theoretical and Applied Mechanics, Siberian Branch, Academy of Sciences of the USSR). Sov. J. Quantum Electron. 5: No. 5, 583-585 (May 1975).

The results are reported of measurements of the gain obtained at high input energy densities $Q/p = 0.2$–0.8 J·cm^{-3}·atm^{-1}. The gain is calculated on the assumption of a Boltzmann distribution of the vibrational modes of CO_2 and N_2. It is shown that the saturation of the gain with rising Q/p is due to a redistribution of the energy between the upper vibrational levels. (auth)

2877 THOMSON SCATTERING INVESTIGATION OF THE PLASMA IN A CARBON DIOXIDE GAS-DISCHARGE LASER. Kuklev, Yu.I.; Sokolov, I.I.; Gerlivanova, O.G. Sov. J. Quantum Electron. 5: No. 5, 591-593 (May 1975).

The results are reported of an experimental investigation of the electron density and temperature in the plasma of a sealed CO_2 gas-discharge laser. The investigation was carried out using the Thomson scattering and a ruby laser as a radiation source. The Thomson scattered radiation was recorded with a time-selective photon counter. A FÉU-79 photomultiplier, operated in the "one-electron" regime, was used as the detector of the scattered light. (auth)

2878 FREQUENCY CHARACTERISTICS OF A ZEEMAN LASER WITH AN ANISOTROPIC RESONATOR. Atutov, S.N.; Koronkevich, V.P.; Lokhmatov, A.I.; Smirnov, G.I. (Institute of Automation and Electrometry, Siberian Branch, Academy of Sciences of the USSR, Novosibirsk). Sov. J. Quantum Electron. 5: No. 5, 598-599 (May 1975).

Theoretical and experimental investigations were made of the dependence of the emission frequency of a stabilized Zeeman laser on the intensity of a longitudinal magnetic field at different pressures in the active medium. The experimental dependence was attributed to the weak anisotropy of the resonator mirrors. The experimental results were in qualitative agreement with the theory. (auth)

2879 VIBRATIONAL RELAXATION IN MOLECULAR LASERS AT A HIGH PUMPING LEVEL. Novobrantsev, I.V.; Starostin, A.N. (M. V. Lomonosov Moscow State University). High Temp. 13: No. 1, 20-27 (Sept 1975).

The stationary-solution stability of the vibrational-relaxation equation is studied for the CO_2 laser. A parameter range is found, in which decay instability is generated, leading under certain conditions to self-oscillation of the average number of quanta in the vibrational modes of the gas mixture. The influence of temperature variation on the generated instability and the effect of the latter on light generation are considered. (auth)

2880 CESIUM-SEEDED CO_2 ELECTRIC-DISCHARGE LASER. Zuev, B.K.; Ivanov, R.S.; Karpukhin, V.T.; Korolev, N.M.; Malikov, M.M.; Nedospasov, A.V.; Stotskii, G.I.; Shelkov, E.M. (Institute of High Temperatures, Academy of Sciences of the USSR). High Temp. 13: No. 1, 206-207 (Sept 1975).

We report the properties of a CO_2 laser with He and Cs additions. (AIP)

2881 ALIGNMENT OF ATOMIC STATES BY THE FIELD OF LASER EMISSION AND ITS EFFECT ON LASER PERFORMANCE. Voitovich, A.P.; Shkadarevich, A.P. Opt. Spectrosc. (USSR) 38: No. 6, 679-682 (June 1975).

It is demonstrated that the primary influence on the increase in lasing power W in a He–Ne laser with the application of a weak longitudinal magnetic field H is a distortion by the magnetic field of the alignment of the atomic states induced by the laser radiation. The spacing of the dips in the velocity distribution of the excited atoms does not play a significant role here. It is proposed that the nonlinear effects of the competition type of transitions be used in order to intensify the effect of the dip spacing on the dependence $W(H)$. The effect of the dip spacing on the form of the dependence $W(H)$ was experimentally demonstrated in a laser with a polarization-isotropic resonator, where alignment is lacking. Alignment has a decisive effect on the radiation polarization, and in a laser with a nonlinearly absorbing cell and a polarization-isotropic resonator it results in the radiation being identically polarized on all modes (in contrast to a laser without an absorbing cell). (auth)

2882 COHERENCE BRIGHTENING AND LASER LETHARGY IN X-RAY LASER AMPLIFIERS. Hopf, F. A.; Meystre, P.; Scully, M. O.; Seely, J. F. (Univ. of Arizona, Tucson). Phys. Rev. Lett.; 35: No. 8, 511-513(25 Aug 1975).

The lethargic response of the lasing medium produced by the combined effects of finite bandwidth and rapid decay of the population inversion leads to a reduction of the linear gain expected in certain x-ray laser amplifiers. However, the effects of coherence brightening are also important, and in the superradiant regime, the laser output approaches that predicted by the usual calculation. (auth)

2883 WIDTH OF SYNCHRONIZATION BAND IN A SOLID-STATE RING LASER. Klochan, E. L.; Kornienko, L. S.; Kravtsov, N. V.; Lariontsev, E. G.; Shelaev, A. N. (Moscow State Univ.). JETP Lett. (USSR) (Engl. Transl.); 21: No. 1, 13-14(5 Jan 1975).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 21: No. 1, 30-33(5 Jan 1975).

It was established that: (1) unlike in a gas laser, there are synchronization regimes that do not go over into the beat regime with increasing revolution velocity and, (2) a transition of self-modulation regimes to the synchronization regime is possible at high revolution velocities. (auth)

2884 OPERATION OF A LASER WITH A PHOTOTROPIC SHUTTER IN A DETUNED LASER RESONATOR. Ermakov, B. A.; Lukin, A. V.; Lyubimov, V. V. Opt. Spectrosc.; 38: No. 4, 434-436(Apr 1975).

Translated from Opt. Spektrosk; 38: No. 4, 766-770(Apr 1975).

The effect of detuning a laser resonator containing a phototropic shutter on the increase in the lasing cross section of a ruby crystal and on the energy output of the laser is studied experimentally and computationally. (auth)

2885 COUPLED TWO-DIMENSIONAL COMPUTER ANALYSIS OF CW CHEMICAL MIXING LASERS. Tripodi, R.; Coulter, L. J.; Bronfin, B. R.; Cohen, L. S. (United Technologies Research Center, East Hartford, CT). AIAA (Am. Inst. Aeronaut. Astronaut.) J.; 13: No. 6, 776-784(Jun 1975).

From 12th aerospace sciences meeting; Washington, DC (30 Jan 1974).

The advantages of utilizing chemical reactions to support laser emission have been recognized for several years. However, a central problem identified in a variety of cw chemical mixing lasers is the dominance of gas-dynamics on the character of the flowing active medium, pointing to the need for a theoretical model that couples the effects of fluid mechanics of mixing with the non-equilibrium kinetics and the cascade of vibrational-rotational laser transitions. As one of the efforts to meet this need, a two-dimensional, rate equation model has been developed. A detailed discussion of the computer model is presented, as well as sample calculations for a representative "cold reaction" HF laser. Comparisons are made with experiment where appropriate. (auth)

2886 INTERACTION BETWEEN UNSTABLE OPTICAL RESONATOR AND CW CHEMICAL LASER. Mirels, H. (Aerospace Corp., El Segundo, CA). AIAA (Am. Inst. Aeronaut. Astronaut.) J.; 13: No. 6, 785-791(Jun 1975).

The primary objective of the study was to determine the effect of the optical resonator magnification and centerline location on the near-field output power from a cw chemical laser. Geometric optics are used. The flowing gain medium is assumed to be adjacent to one of the resonator mirrors. Analytic solutions are obtained in the limits M yields 1 and M much greater than 1, where M is cavity magnification. Effects of resonator and laser medium parameters on laser output power are then discussed. Turbulent and laminar diffusion is considered. (TFD)

2887 SINGLE LASER BEAM OF SPATIAL COHERENCE FROM AN ARRAY OF GaAs LASERS: FREE-RUNNING MODE. Philipp-Rutz, E.M. (IBM Federal Systems Division, Gaithersburg, Maryland 20760). J. Appl. Phys. 46: No. 10, 4552-4556 (Oct 1975).

Spatially coherent radiation from a monolithic array of three GaAs lasers in a free-running mode is reported. The lasers, with their mirror faces antireflection coated, are operated in an external optical cavity built of spherical lenses and plane mirrors. The spatially coherent beam formation makes use of the Fourier transformation property of the internal lenses. The transverse mode control is accomplished by a spatial filter. The optical cavity is similar to that used for the phase-controlled mode of spatially coherent beam formation, which had been reported; only the spatial filters are different. The spatial filter in the free-running mode controls the fields of the lasers to be in the lowest-order transverse mode, but it does not control their phase angles. Random amplitude and phase variations of the longitudinal modes prevent the formation of a stationary interference waveform. In the far field (when restored by an external lens), the intensities of the lasers in the array are concentrated in a single laser beam of spatial coherence, without any grating lobes. The far-field distribution is not influenced by the spacings among the lasers. The far-field distribution of the laser array in the free-running mode differs significantly from the interference pattern of the phase-controlled mode. The modulation characteristics of the optical waveforms of the two modes are also quite different. This is because the modulation is related to the interaction of the spatial filter with the longitudinal modes of the laser array with the optical cavity. The modulation of the optical waveform of the free-running mode is nonperiodic, confirming that the fluctuations of the optical fields of the lasers are random. Experiments were performed at room temperature using a monolithic array of three GaAs lasers. The far-field distribution of the laser array and the optical waveform were investigated. (auth)

2888 cw CHEMICAL LASERS PUMPED BY VIBRATIONAL ENERGY TRANSFER: CO/CO_2 AND CO/N_2O. Petersen, A.B.; Wittig, C. (Electrical Engineering Department, University of Southern California, University Park, Los Angeles, California 90007); Coleman, P.D. J. Appl. Phys. 46: No. 10, 4570-4572 (Oct 1975).

A continuous-wave chemical laser has been constructed which produces simultaneous output from CO and either CO_2 or N_2O laser species. Excitation of the CO is chemical, via the $O+CS \rightarrow CO^{\dagger}+S$ reaction, and excitation of the triatomic is by vibrational energy transfer from $CO^{\dagger}$. Output powers of >3.0 W and >0.6 W have been obtained from CO and the triatomics, respectively. (auth)

2889 LITHIUM NEODYMIUM TETRAPHOSPHATE LASER. Otsuka, K.; Yamada, T.; Nakano, J.; Kimura, T.; Saruwatari, M. (Musashino Electrical Communication Laboratory, Nippon Telegraph and Telephone Public Corporation, Musashino-shi, Tokyo, Japan). J. Appl. Phys. 46: No. 10, 4600-4601 (Oct 1975).

Laser action at $\lambda=1.047$ μm is reported in a lithium neodymium tetraphosphate crystal (LNP; $LiNdP_4O_{12}$) pumped longitudinally with a rhodamine 6G laser ($\lambda=5965$ Å) or a chopped Ar ion laser ($\lambda=5145$ Å). Comparing the measured threshold and round-trip loss of the resonator of the LNP laser with that of the Nd:YAG laser, the effective emission cross section for the ion in the $^4F_{3/2}$ manifold of LNP is found to be 1.65 times that of Nd:YAG. (auth)

2890 354-nm LASER ACTION ON XeF. Brau, C.A.; Ewing, J.J. (Avco Everett Research Laboratory, Inc., Everett, Massachusetts 02149). Appl. Phys. Lett. 27: No. 8, 435-437 (15 Oct 1975).

This letter reports laser action on the xenon monofluoride $^2\Sigma_{1/2} \rightarrow {}^2\Sigma_{1/2}$ band at 354 nm. Lasing on discrete vibrational bands has been achieved by pulse excitation of high-pressure mixtures of $F_2/Xe/Ar$ with an electron beam. XeF is a member of a new class of diatomic molecules, the noble gas monohalides, which all exhibit similar molecular structure and spectra, and laser action should be attainable on the various bands of other members of this class of molecules. The kinetics and loss mechanisms of these laser candidates are briefly discussed. (auth)

2891 SPECTRAL NARROWING AND ELECTRO-OPTICAL TUNING OF A PULSED DYE LASER BY INJECTION LOCKING TO A cw DYE LASER. Turner, J.J.; Moses, E.I.; Tang, C.L. (Cornell University, Ithaca, New York, 14853). Appl. Phys. Lett. 27: No. 8, 441-443 (15 Oct 1975).

It is shown that the single-element electro-optical birefringent filter can be used to tune the relatively high-gained flashlamp-pumped pulsed dye laser across the entire dye emission band, but the resulting laser line width is relatively wide as might be expected. However, this line width could be drastically reduced without losing the tunability by injection locking the pulsed laser to an electro-optically tuned cw dye laser. The beam direction, collimation, spectral width, and stability of the pulsed laser can, therefore, all be precisely controlled through the cw laser beam. (auth)

2892 LANTHANUM BERYLLATE: A NEW RARE-EARTH ION LASER HOST. Morris, R.C.; Cline, C.F.; Begley, R.F.; Dutoit, M.; Harget, P.J.; Jenssen, H.P.; La France, T.S.; Webb, R. (Materials Research Center, Allied Chemical Corporation, Morristown, New Jersey 07960). Appl. Phys. Lett. 27: No. 8, 444-445 (15 Oct 1975).

Optical quality crystals, measuring up to 2.5×20 cm, of the compound $La_2Be_2O_5:Nd^{3+}$ have been grown from the melt. The results of physical- and optical-property measurements and laser testing (long pulse, Q switched, and cw mode) are reported. Linearly polarized laser oscillations at 1.07 and 1.08 μm are observed. Long-pulse slope efficiencies about 60% greater than for YAG : Nd at comparable pumping thresholds and Q-switched energy storage nearly three times that of YAG : Nd are also observed. (auth)

2893 cw DOUBLE MODE LOCKING OF THE DYE LASER EXPERIMENT. Yasa, Z.A.; Teschke, O. (Electronics Research Laboratory, University of California, Berkeley, California 94720). Appl. Phys. Lett. 27: No. 8, 446-447 (15 Oct 1975).

A mixture of rhodamine 6G and cresyl violet is pumped by a cw argon laser. Inversion of cresyl violet by the absorption of the lasing rhodamine 6G wavelength results in doubly mode-locked operation, with an ultrashort pulse at 5740 Å followed by an ultrashort pulse at 6440 Å. (auth)

2894 THERMAL SELF-FOCUSING OF TEM_{01} LASER BEAMS AND RING-SHAPE SELF-FOCUSING OF TWO SPECIFIC MIXTURES OF MODES. Sodha, M.S. (Physics Department, Indian Institute of Technology, New Delhi–110029, India); Nayyar, V.P. J. Opt. Soc. Am. 65: No. 9, 1027-1030 (Sept 1975).

Thermal focusing and defocusing of a laser beam in an absorbing dielectric is studied when the laser operates in the TEM_{01} mode. The paraxial-ray approximation is employed to obtain an analytical solution of the wave equation. When the refractive index decreases with increasing temperature, the electromagnetic energy converges in the x direction and diverges in the y direction; the reverse is the case when the refractive index increases with increasing temperature. The authors have also studied the geometric-optics self-focusing of laser beams operating in the (i) doughnut mode and (ii) mixed TEM_{00} and TEM_{10} cylindrical modes oscillating in phase opposition. In both cases, the energy of the beam concentrates around a circular ring of maximum irradiance. (auth)

2895 ELECTRON-BEAM-CONTROLLED DISCHARGE PUMPING OF THE KrF LASER. Mangano, J.A.; Jacob, J.H. (Avco Everett Research Laboratory, Everett, Massachusetts 02149). Appl. Phys. Lett. 27: No. 9, 495-498 (1 Nov 1975).

Laser action has been obtained in atmospheric-pressure mixtures of 0.1% F_2/2% Kr/97.9% Ar at 248.5 and 249.5 nm with electron-beam-controlled discharge pumping. The laser and discharge characteristics are explored as a function of discharge electric field and total mixture pressure. These preliminary measurements indicate laser output energies up to 6 mJ with a pulse length of 90 nsec. Limiting efficiencies for this laser system are discussed. (auth)

2896 OPTICALLY PUMPED INFRARED V-V TRANSFER LASERS. Kildal, H.; Deutsch, T.F. (Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, Massachusetts 02173). Appl. Phys. Lett. 27: No. 9, 500-502 (1 Nov 1975).

Laser action in OCS, CO_2, N_2O, C_2H_2, and CS_2 has been obtained by resonant vibrational-to-vibrational (V-V) energy transfer from CO gas excited by a frequency-doubled CO_2 TEA laser. Output energies up to 0.5 mJ, energy conversion efficiencies as high as 7%, and thresholds as low as 0.1 mJ have been observed. (auth)

2897 INTENSE LASER EMISSION AT 3577 Å USING N_2-SF_6 MIXTURES IN A TE NITROGEN LASER. Itani, J.; Kagawa, K.; Kimura, Y. (Department of Physics, Konan University, Okamoto, Kobe, Japan). Appl. Phys. Lett. 27: No. 9, 503-504 (1 Nov 1975).

Intense laser emission at 3577 Å ($v=0$ of the $C^3\pi_u$ state to $v=1$ of the $B^3\pi_g$ state of the nitrogen molecule) has been demonstrated to take place by an addition of a large quantity of SF_6 as a foreign gas in a transversely excited nitrogen laser. The output at 3577 Å is increased with increasing partial pressure of SF_6, until a total pressure of up to 250 Torr. With sufficient SF_6 added, the output at 3371 Å is increased by a factor of 1.3 as compared with the case of N_2 gas alone. (auth)

2898 ETCHED BURIED HETEROSTRUCTURE GaAs/GaAlAs INJECTION LASERS. Burnham, R.D.; Scifres, D.R. (Palo Alto Research Center, Palo Alto, California 94304). Appl. Phys. Lett. 27: No. 9, 510-511 (1 Nov 1975).

An injection laser is described in which a semicircular GaAs active region is completely surrounded by $Ga_{1-x}Al_xAs$ by using selective etching and a single liquid-phase epitaxial growth. The active region dimensions can be made much more symmetric than those obtained with conventional stripe geometry lasers resulting in improved optical characteristics and low room-temperature threshold currents. (auth)

2899 SOFT EXCITATION OF STIMULATED TWO-PHOTON EMISSION. Krochik, G.M.; Khronopulo, Yu.G. (Instiutte of Radio Engineering and Electronics, USSR Academy of Sciences). JETP Lett. 21: No. 10, 274-276 (20 May 1975).

It is proposed to realize soft excitation of a two-phonon laser with the aid of a four-wave parametric process. The working medium can be vapor. Estimates of the laser parameters in different regimes are presented. (auth)

2900 STABILIZATION OF RUBY LASER RADIATION BY AN EXTERNAL NEGATIVE FEEDBACK. Krivoshchekov, G.V.; Makukha, V.K.; Tarasov, V.M. (Institute of Semiconductor Physics, Siberian Branch, Academy of Sciences of the USSR, Novosibirsk). Sov. J. Quantum Electron. 5: No. 4, 394-396 (Apr 1975).

The intensity and emission spectrum of a ruby laser, stabilized by an external negative feedback, were determined. An experimental study was made of the influence of the delay time and strength of feedback on the stabilization of the radiation intensity. The effects of perturbations of the Q factor of the resonator on the stabilization were investigated. It was found that the sensitivity of the laser to perturbations did not exhibit resonance at some perturbation frequency. (auth)

2901 INVESTIGATION OF THE DIVERGENCE OF RADIATION EMITTED BY A PHOTODISSOCIATION LASER WITH AN INHOMOGENEOUS ACTIVE MEDIUM. Kirillov, G.A.; Kormer, S.B.; Kochemasov, G.G.; Kulikov, S.M.; Murugov, V.M.; Nikolaev, V.D.; Sukharev, S.A.; Urlin, V.D. Sov. J. Quantum Electron. 5: No. 4, 369-372 (Apr 1975).

An investigation was made of the dependence of the energy and divergence of laser radiation on the length of a plane-parallel resonator. The results were in agreement with estimates based on relationships derived in the geometric-optics framework. An analysis was made of the possibility of obtaining highly directional radiation from a laser with a nonresonant feedback and parameters of this radiation were measured. It was found that the experimentally achieved divergence was close to the "amplifier divergence" ($\theta \sim 2l_a \nabla n \simeq \theta_{amp}$) and the energy losses were still relatively low. (auth)

2902 CALCULATION OF THE PARAMETERS OF AN ACTIVE MEDIUM OF AN ELECTRON-BEAM-EXCITED PLASMA LASER. Syts'ko, Yu.I.; Yakovlenko, S.I. (Moscow Engineering-Physics Institute). Sov. J. Quantum Electron. 5: No. 4, 364-368 (Apr 1975).

Calculations are made of the parameters of a plasma generated by an electron beam (j=10–100 A/cm^2, $V\sim$10 keV) bombarding a dense (10^{18}–10^{19} cm^{-3}) gaseous mixture of helium and molecular hydrogen. The populations of the excited states of helium are calculated and the gain is computed for transitions between the states with $n=3$ and $n=2$. The results obtained show that it should be possible to build a quasicontinuously operating beam plasma laser using helium with impurities. (auth)

2903 COHERENCE OF RADIATION EMITTED BY SEMICONDUCTOR LASERS AND USE OF THESE LASERS IN HOLOGRAPHY (REVIEW). Bykovskii, Yu.A.; Elkhov, V.A.; Larkin, A.I. (Moscow Engineering-Physics Institute). Sov. J. Quantum Electron. 5: No. 4, 357-363 (Apr 1975).

This review is concerned with the methods of measuring coherence of the radiation emitted by semiconductor lasers and with the relationship of the mode structure to coherence. The frequency composition of the radiation and the presence of a noncoherent spontaneous component are discussed. Methods for increasing the coherence in question are considered. Major applications of semiconductor lasers in holography and methods for the optimization of the properties of these lasers are also reviewed. (auth)

2904 DYE LASER WITH A DISTRIBUTED FEEDBACK INDUCED BY SECOND HARMONIC OF NEODYMIUM LASER. Éfendiev, T.S.; Rubinov, A.N. (Institute of Physics, Academy of Sciences of the Belorussian SSR, Minsk). Sov. J. Quantum Electron. 5: No. 4, 478-480 (Apr 1975).

An investigation was made of different methods of tuning the stimulated emission lines of a dye laser with a distributed feedback induced by the second harmonic of a neodymium laser. The maximum tuning range for rhodamine 6G was 58 nm when the spectral width of the emission line was 0.1 Å and the efficiency was 16%. A theoretical analysis was made and an experimental study was carried out of the conditions for the simultaneous stimulated emission of two or more dye laser frequencies in the presence of the corresponding number of spectral components in the pump radiation. (auth)

2905 ONE POSSIBILITY OF INCREASING THE BRIGHTNESS OF NEODYMIUM-GLASS LASER RADIATION. Mak, A.A.; Mit'kin, V.M.; Polukhin, V.N.; Stepanov, A.I.; Shchavelev, O.S. Sov. J. Quantum Electron. 5: No. 4, 473-475 (Apr 1975).

An attempt was made to compensate the thermal deformation of the active element of a laser by deliberate optical distortions counteracting the thermo-optic distortions induced during laser operation. It was found that a special heat treatment of the active element compensated both the optical inhomogeneity and anisotropy in a certain range of pumping powers, which imposed additional requirements on the thermo-optic properties of the active material. Moreover, this heat treatment increased fourfold or fivefold the thermal stability of the active element. (auth)

2906 NEW LASER TRANSITIONS IN THE SPECTRUM OF TIN AND POPULATION INVERSION MECHANISM. Zhukov, V.V.; Latush, E.L.; Mikhalevskii, V.S.; Sém, M.F. (Rostov State University). Sov. J. Quantum Electron. 5: No. 4, 468-469 (Apr 1975).

A stimulated emission of the 558.9, 579.9, 1062, and 1074 nm lines in the spectrum of Sn II and of the 657.9 nm line in the spectrum of Sn I was achieved. The ion laser transitions were pumped by the recombination of Sn^{2+} and by the charge exchange in collisions of helium or neon ions with tin atoms. (auth)

2907 MUTUALLY MATCHED STIMULATED EMISSION AND LASER PLASMA GENERATION. Bokhonov, A.F.; Burakov, V.S.; Zhukovskii, V.V.; Stavrov, A.A. (Institute of Physics, Academy of Sciences of the Belorussian SSR, Minsk). Sov. J. Quantum Electron. 5: No. 4, 464-466 (Apr 1975).

Regular stimulated emission was obtained from a ruby laser by varying the resonator Q factor with plasma jets. These jets formed as a result of an interaction between part of the laser radiation and a target placed between a mirror and the end of the ruby element near the caustic surface. The kinetics of the laser emission was controlled by employing different target materials (zirconium, tungsten, iron, carbon, PTK Textolite, and others). The time and energy characteristics of the ruby laser were determined. The relationship between the nature of the change in the absorptivity of the plasma and the stimulated emission was established. (auth)

2908 TUNABLE DYE LASER PUMPED TRANSVERSELY BY AN ULTRAVIOLET LASER. Ishchenko, V.N.; Lisitsyn, V.N.; Chernenko, A.A. (Institute of Semiconductor Physics, Siberian Branch, Academy of Sciences of the USSR, Novosibirsk). Sov. J. Quantum Electron. 5: No. 4, 461-462 (Apr 1975).

A report is made of the construction of a rhodamine 6G laser pumped transversely by an ultraviolet nitrogen laser. The width of the spectrum of the dye laser was ~0.002 nm, its output power was 2.5 kW, and it was characterized by a good frequency reproducibility. The dye laser was tunable over a range of 35 nm with a maximum at λ = 590 nm for a given dye concentration. (auth)

2909 TUNABLE HF (DF) LASER INITIATED BY PULSE Co_2 LASER RADIATION. Balykin, V.I.; Kolomiiskii, Yu.R.; Tumanov, O.A. (Institute of Spectroscopy, Academy of Sciences of the USSR, Akademgorodok, Moscow Province). Sov. J. Quantum Electron. 5: No. 4, 454-456 (Apr 1975).

The laser action was achieved as a result of the initiation of chemical reactions in $SF_6 + H_2$, $SF_6 + C_3H_8$, and $SF_6 + D_2$ mixtures by pulse CO_2 laser radiation. The emission spectrum was recorded and tuning was achieved by selecting one vibration-rotational transition in the range 3200–3700 cm^{-1} in the case of HF and in the range 2450–2650 cm^{-1} in the case of DF. (auth)

2910 CHARACTERISTICS OF DIFFUSED InP AND InP_xAs_{1-x} LASER DIODES. Ismailov, I.; Sadiev, A.; Altynbaev, R.; Shokhudzhaev, N. (S. U. Umarov Physicotechnical Institute, Academy of Sciences of the Tadzhik SSR). Sov. J. Quantum Electron. 5: No. 4, 451-454 (Apr 1975).

The main characteristics of InP and InP_xAs_{1-x} injection laser diodes were determined at 4.2 and 77 °K. The spectral, threshold, power, temporal, and spatial properties of the laser radiation were investigated in the wavelength range λ = 900–1100 nm. The best results at 77 °K were obtained for InP lasers whose characteristics included a threshold current density of 1.7 kA/cm^2, an output power of 16 W, and an efficiency of 26%. (auth)

2911 TWO-MODE EMISSION FROM A RING GAS LASER WITH A TWO-ISOTOPE ACTIVE MEDIUM. Sokolov, V.A.; Fradkin, E.E. (Leningrad State University). Sov. J. Quantum Electron. 5: No. 4, 447-449 (Apr 1975).

A theoretical analysis is made of steady-state two-mode (two- and four-wave) emission from a ring gas laser with a two-isotope active medium. The interaction coefficients of traveling waves are calculated for two longitudinal linearly polarized modes. Two cases are considered: Modes polarized in one direction and at right-angles to one another. The limits of stability of the two-mode (two- and four-wave) emission are investigated as a function of the following parameters of a ring gas laser: mode spacing, positions of modes on the gain curve, longitudinal dimensions and relative positions of tubes with the active medium, lifetimes and total momentum of the active levels, and width of the spontaneous emission line. (auth)

2912 PHOTOCHEMICAL LASER UTILIZING THE $^1\Sigma^+_g$–$^3\Sigma^-_g$ VIBRONIC TRANSITION IN S_2. Zuev, V.S.; Mikhoev, L.D.; Yalovoi, V.I. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). Sov. J. Quantum Electron. 5: No. 4, 442-446 (Apr 1975).

An experimental investigation was made of the $^1\Sigma^+_g$–$^3\Sigma^-_g$ vibronic laser transition in molecular sulfur formed as a result of secondary reactions in the photodissociation of COS by $\lambda = 190$–255 nm radiation. The population inversion preceding this transition was analyzed. The main experimental results were in agreement with the adopted model of the stimulated emission due to the $^1\Sigma^+_g$–$^3\Sigma^-_g$ transition in S_2. The emission spectrum was located mainly in the range of vibronic bands $\Delta v = 0$ ($\lambda_L \simeq 1.1$ μ). The gain reached $\sim 4 \times 10^{-3}$ cm^{-1}. The specific output energy was $\sim 5 \times 10^{-4}$ J/cm^3. (auth)

2913 THIN-FILM RING LASER WITH WAVEGUIDE PUMPING. Deryugin, L.N.; Cheremiskin, I.V.; Chekhlova, T.K. (Patrice Lumumba Friendship of Nations University, Moscow). Sov. J. Quantum Electron. 5: No. 4, 439-442 (Apr 1975).

A waveguide-pumped thin-film ring laser, using rhodamine 6G as the active substance, was constructed and investigated. Measurements were made of the threshold pump power (22 W), radiation directionality coefficient (2–50), emission wavelength (580–600 nm), and width of emission line (0.6–1 nm). The gain was calculated for two models of an organic dye amplifier with an exponential distribution of the pump intensity along the amplifier. An estimate was obtained of the minimum pump power necessary for the excitation of the investigated thin-film ring laser. (auth)

2914 MODULATION OF GAS LASER RADIATION BY AN ALTERNATING MAGNETIC FIELD. Akchurin, G.G.; Sedel'nikov, V.A.; Tuchin, V.V. (N. G. Chernyshevskii State University, Saratov). Sov. J. Quantum Electron. 5: No. 4, 436-439 (Apr 1975).

A semiclassical vector theory of a Zeeman gas laser is used in an analysis of the amplitude and frequency modulation of linearly polarized radiation. Arbitrary detuning of the emission frequency relative to the center of the laser transition is discussed. It is assumed that the active medium is modulated by an alternating magnetic field. The steepness of the dispersion characteristic and the depth of modulation of the intensity at the second harmonic of the modulation frequency are both functions of the parameters of the active medium, resonator, and magnetic field amplitude. A qualitative agreement is reported between the experimental results obtained for an He–Ne laser (λ=0.63 μ) and the theoretical calculations. The results may be useful in studies of fluctuations of gas-laser radiation due to the application of alternating magnetic fields; they may also be applied in the design of some frequency stabilization systems and in laser-spectroscopic determinations of the constants of the active atoms under stimulated emission conditions. (auth)

2915 HIGH-FREQUENCY SELF-MODULATION OF THE RADIATION EMITTED BY A LINEAR LASER WITH CONSTANT LOSSES. Loiko, N.A.; Samson, A.M. (Institute of Physics, Academy of Sciences of the Belorussian SSR, Minsk). Sov. J. Quantum Electron. 5: No. 4, 427-431 (Apr 1975).

A theoretical analysis is made of the appearance of high-frequency pulsations in a linear laser with constant losses. Nonlinear differential equations with a variable parameter are used for the radiation density and gain of the active medium. It is shown that the high-frequency self-modulation is to the delay of the action on the active medium of the radiation arriving from different points in the laser. The dependence of the period and depth of modulation on the laser parameters is obtained. The results of analytic investigations are compared with computer calculations. (auth)

2916 CONTINUOUSLY OPERATING HIGH-PRESSURE CARBON DIOXIDE LASERS. Provorov, A.S.; Chebotaev, V.P. (Institute of Semiconductor Physics, Siberian Branch, Academy of Sciences of the USSR, Novosibirsk). Sov. J. Quantum Electron. 5: No 4, 413-419 (Apr 1975).

A study was made of continuous-wave (cw) high-pressure CO_2 lasers with discharges in capillary tubes. The maximum pressure at which stimulated emission could be obtained was determined as a function of the radius and temperature of the discharge wall tubes, and of the rate of pumping of the gas mixture. A high-pressure CO_2 laser with a waveguide resonator was studied. The optimal relationship between the size of the field at the waveguide input and the guide radius was determined. A theoretical analysis was made of the possibility of achieving continuous emission at atmospheric pressure. A similarity principle was derived for a population inversion in a CO_2–N_2–He mixture at the maximum gas density in the case thermal excitation of the lower laser level. An analytic dependence of the gain on the gas density and tube radius was obtained. The results of these calculations were compared with the experimental data. (auth)

2917 SPECTRAL SELECTION OF RADIATION EMITTED FROM LASERS WITH UNSTABLE RESONATORS. Anan'ev, Yu.A. Grishmanova, N.I.; Petrova, I.M.; Sventsitskaya, N.A. Sov. J. Quantum Electron. 5: No. 4, 408-410 (Apr 1975).

An analysis was made of the possibility of spectral selection in lasers with unstable resonators. A study was made of the properties of a system composed of a telescopic resonator with an axial coupling aperture and an additional mirror placed opposite this aperture. It was found that this system provided efficient spectral selection and retained all the advantages of an ordinary telescopic resonator. (auth)

2918 ENERGY AND POLARIZATION CHARACTERISTICS OF A NEODYMIUM-GLASS LASER WITH PLANE-PARALLEL AND TELESCOPIC RESONATORS. Alekseev, V.N.; Gorokhov, A.A. Sov. J. Quantum Electron. 5: No. 4, 405-408 (Apr 1975).

A study was made of the influence of the birefringence of the active medium on the energy and polarization characteristics of a laser with an intraresonator polarizer. The relevant quantities were calculated on a computer. It was found that a slight birefringence had less influence on the polarization characteristics of the laser radiation when a telescopic resonator was used. (auth)

2919 INVESTIGATION OF A PERIODICALLY EMITTING NEODYMIUM GLASS LASER UNDER TRANSIENT THERMAL CONDITIONS. Buchenkov, V.A.; Kolesnikov, B.N.; Mit'kin, V.M.; Perlov, D.I.; Stepanov, A.I. Sov. J. Quantum Electron. 5: No. 4, 403-405 (Apr 1975).

An investigation was made of the periodic emission from a laser whose neodymium-glass element was force cooled by a circulating liquid or it was cooled by free convection. The energy and divergence, the latter being measured at 0.1 of the maximum intensity level, were determined for different operating conditions. The laser radiation parameters were compared with the deformation of the active element. A method for accelerating the attainment of quasicontinuous emission was tested. (auth)

2920 LASER FREQUENCY CONTROL WITH BIREFRINGENT POLARIZING FILTERS. Lopasov, V.P.; Makogon, M.M. (Institute of Atmospheric Optics, Siberian Branch, Academy of Sciences of the USSR, Tomsk). Sov. Phys.—Tech. Phys. 20: No. 2, 216-222 (Feb 1975).

Four types of electro-optical birefringent polarizing filters are proposed and designed. The selectivity is analyzed and the characteristics of various filters are compared. The use and construction of such filters for controlling laser frequencies are discussed. Data are reported on several crystals which seem promising for use in such filters, and the use of such filters to control the lasing mode is reported. It is shown theoretically and experimentally that the lasing frequency can be tuned over essentially the entire luminescence band of the active medium; electro-optical control makes it possible to program the frequency. (auth)

Cryogenic and Superconducting Equipment and Devices

2921 (CONF-751113-5) DIELECTRIC BREAKDOWN IN LIQUID HELIUM. Miller, F. L. Jr. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Nuclear Div.). 1975. 9p. Dep. NTIS $4.50.

From 1st ERDA statistical symposium; Los Alamos, New Mexico, USA (3 Nov 1975).

The experimental apparatus consists of a 130 kV dc 80 kV ac intermediate voltage unit and a 600 kV dc 700 kV high voltage unit under construction. The experimental devices consist of an insulated container, or dewar, in which two electrodes are placed, one above the other. A voltage is built up in one electrode until an arc occurs to the other electrode. A typical set of breakdown data is shown. A mathematical analysis is briefly described. (MOW)

2922 (COO-2522-1) IMPROVED SUPERCONDUCTOR FOR TRANSMISSION LINE APPLICATIONS, PHASE I. Final Report, January 1, 1975–June 30, 1975. Braginski, A. I.; Mauser, S. F.; Roland, G. W.; Burghardt, R. R.; Daniel, M. R.; Janocko, M. A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). 1975. Contract E(11-1)-2522. 133p. Dep. NTIS $7.00.

The analysis of an existing superconducting power transmission cable design indicated that economic benefits in the area of refrigeration can be derived from the substitution of Nb_3Ge superconductor for the presently planned Nb_3Sn. However, the cost of Nb_3Ge must be comparable to that of Nb_3Sn, which is achievable when preparing Nb_3Ge by the chemical vapor deposition. Alternatively, technical benefits can be obtained. The most essential and prerequisite requirement is that the Nb_3Ge critical current density be improved significantly over the present state-of-the art. Other properties of Nb_3Ge are generally suitable for the transmission line application and/or require only moderate improvements. (auth)

2923 DOPED JOSEPHSON TUNNELING JUNCTION FOR USE IN A SENSITIVE IR DETECTOR. Fletcher, J. C.; Saffren, M. M. US Patent 3,906,231. 16 Sep 1975. Filed Date 19 Mar 1974. 14p.

A superconductive tunneling device having a modified tunnel barrier capable of supporting Josephson tunneling current is provided. The tunnel barrier located between a pair of electrodes includes a molecular species which is capable of coupling incident radiation of a spectrum characteristic of the molecular species into the tunnel barrier. The coupled radiation modulates the known Josephson characteristics of the superconducting device. As a result of the present invention, a superconductive tunneling device can be tuned or made sensitive to a particular radiation associated with the dopant molecular species. The present invention is particularly useful in providing an improved infrared detector. The tunnel barrier region can be, for example, an oxide of an electrode or frozen gas. The molecular species can be intermixed with the barrier region such as the frozen gas or deposited as one or more layers of molecules on the barrier region. The deposited molecules of the molecular species are unbonded and capable of responding to a radiation characteristic of the molecules. Semi-conductor material can be utilized as the molecular species to provide an increased selective bandwidth response. Finally, appropriate detector equipment can be utilized to measure the modulation of any of the Josephson characteristics such as critical current, voltage steps, Lambe–Jaklevic peaks and plasma frequency. (auth)

2924 SENSITIVE PRESSURE MONITORING DEVICE. Wright, P.W.; Franck, J.P. (Department of Physics, University of Alberta, Edmonton, Alberta, Canada T6G 2J1). Rev. Sci. Instrum. 46: No. 11, 1474-1477 (Nov 1975).

The use of tunnel junctions as pressure monitoring devices in both solid and fluid pressure transmitting media is described. While very sensitive to pressure changes, these devices have been found to have a negligible dependence on temperature over the range 0–77 K. Their pressure response has been found to be reversible and if maintained at temperatures less than 77 K, they can be used for prolonged periods. An actual example of their use at low temperature is given. (auth)

2925 DILUTION REFRIGERATOR STILL WITH ^{4}He FILM-FLOW SUPPRESSION. Pratt, W.P. Jr. (Physics Department, Michigan State University, East Lansing, Michigan 48824). Rev. Sci. Instrum. 46: No. 11, 1578-1581 (Nov 1975).

A still for a ^{3}He–^{4}He dilution refrigerator has been constructed which suppresses the ^{4}He superfluid film flow and attains ^{3}He/^{4}He ratios as large as 600. This design has the novel feature that all the heaters are attached to the outside of the still. (auth)

2926 Ac SUPERCONDUCTING ARTICLES AND A METHOD FOR THEIR MANUFACTURE. Meyerhoff, R. W. (to Union Carbide Corp.). US Patent 3,906,412. 16 Sep 1975. Filed date 11 May 1973. 8 p.

A novel ac superconducting article is described comprising a composite structure having a superconducting surface along with a high thermally conductive material wherein the superconducting surface has the desired physical properties, geometrical shape and surface finish produced by the steps of depositing a superconducting layer upon a substrate having a predetermined surface finish and shape which conforms to that of the desired superconducting article, depositing a supporting layer of material on the superconducting layer and removing the substrate, the surface of the superconductor being a replica of the substrate surface. (auth)

2927 dc ANALYSIS OF PARALLEL ARRAYS OF TWO AND THREE JOSEPHSON JUNCTIONS. Tsang, W.; Van Duzer, T. (Department of Electrical Engineering and Computer Sciences, and the Electronics Research Laboratory, University of California, Berkeley, California 94720). J. Appl. Phys. 46: No. 10, 4573-4580 (Oct 1975).

Arrays of Josephson junctions are becoming of increasing interest, and the dependence of the maximum zero-voltage current on various factors is important in applications. When the array carries the maximum possible zero-voltage current it is said to be in the *critical state*. Sets of equations describing the critical-state behaviors of arrays of two and three junctions are derived. Account is taken of possible differences of the individual critical currents, self-induced flux, and asymmetric current feed. In a space having the phase differences across the junctions as coordinates, one can construct a locus relating the phase differences that are obtained when the array is in the critical state. It is shown that the periodic, symmetric, and other properties of the various relationships between variables can be inferred from the properties of the phase-difference locus. (auth)

2928 NOISE MEASUREMENTS IN SUPERCONDUCTING PROXIMITY BRIDGES. Decker, S.K.; Mercereau, J.E. (California Institute of Technology, Pasadena, California 91125). Appl. Phys. Lett. 27: No. 8, 466-469 (15 Oct 1975).

Experiments and analysis have been done to show that the low-frequency noise voltage developed across a current-biased proximity-coupled superconducting bridge is well described by existing theories of electron tunneling. There is also some evidence that, on a two-fluid model, normal and supercurrent noise may be correlated. The temperature sensitivity of these bridges is calculated from the measured noise spectrum and is found to compare favorably with existing bolometric techniques. (auth)

2929 FREQUENCY CONVERSION IN A LONG JOSEPHSON JUNCTION WITH A MOVING VORTEX ARRAY. Yoshida, K.; Irie, F. (Department of Electronics, Kyushu University, Fukuoka 812, Japan). Appl. Phys. Lett. 27: No. 8, 469-470 (15 Oct 1975).

The dispersion relation of small electromagnetic waves applied in the uniform flux-flow state of a long Josephson junction has been obtained. The results contain exponentially growing waves due to the parametric interaction between the applied fields and the moving vortices, which indicates the possibility of a Josephson-junction frequency converter of the traveling-wave type. (auth)

2930 QUANTUM INTERFERENCE JOSEPHSON LOGIC DEVICES. Zappe, H.H. (IBM Thomas J. Watson Research Center, Yorktown Heights, New York 10598). Appl. Phys. Lett. 27: No. 8, 432-434 (15 Oct 1975).

Experiments with latching and nonlatching quantum interference logic devices are described. The device is a three-junction interferometer, switching with control currents of <0.5 mA. Simple logic functions have been performed with dc-powered nonlatching devices having a power dissipation of <40 nW in continuous operation. (auth)

2931 SURFACE-TEMPERATURE DETERMINATION IN THE KAPITZA PROBLEM. Ridner, A.; Martínez, E.N.; de la Cruz, F. (Centro Atómico Bariloche, Comisión Nacional de Energía Atómica, Instituto de Física "Dr. J. A. Balseiro," Universidad Nacional de Cuyo, Bariloche, Argentina). Phys. Rev. Lett. 35: No. 13, 855-858 (29 Sept 1975).

It is shown that surface superconductivity can be used as a localized thermometer. Its application to the study of the thermal boundary resistance at a Pb–^{4}He interface provides the first experimental evidence for the existence of a rapid temperature variation within microscopic distances from the surface. (auth)

2932 FINITE-AMPLITUDE WAVES IN A SUPERCONDUCTING COAXIAL LINE. Kiselev, M.I. Sov. Phys.—Tech. Phys. 20: No. 2, 238-239 (Feb 1975).

The propagation of deformations and perturbations of the magnetic field in a superconducting transmission line consisting of a coaxial system of elastic shells cooled by streams of cryogenic liquid is treated in the hydrodynamic approximation. (auth)

2933 HIGH-FREQUENCY LIMIT IN THE NONSTATIONARY JOSEPHSON EFFECT. Akimenko, A.I.; Solov'ev, V.S.; Yanson, I.K. (Khar'kov State Research Institute for Metrology). JETP Lett. 21: No. 10, 278-279 (20 May 1975).

The method of mixing two microwave signals in superconducting Nb–Nd point contacts is used to investigate the high-frequency limit in the nonstationary Josephson effect. It is found that generation up to 240 harmonics of a 70-GHz klystron signal is possible, corresponding to a frequency ~ 17 THz. (auth)

Heat Transfer and Fluid Flow

Refer also to abstracts 2851, 3090, 4666, 4667, 4671, 4702, and 4878–4884.

2934 (CONF-751106-13) CHARACTERISTICS AND STABILITY ANALYSES OF TRANSIENT ONE-DIMENSIONAL TWO-PHASE FLOW EQUATIONS AND THEIR FINITE DIFFERENCE APPROXIMATIONS. Lyczkowski, R. W.; Gidaspow, D.; Solbrig, C. W.; Hughes, E. D. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). 1975. 62p. Dep. NTIS $5.50.

From annual meeting of ASME; Houston, Texas, USA (30 Nov 1975).

Equation systems describing one-dimensional, transient, two-

phase flow with separate continuity, momentum, and energy equations for each phase are classified by use of the method of characteristics. Little attempt is made to justify the physics of these equations. Many of the equation systems possess complex-valued characteristics and hence, according to well-known mathematical theorems, are not well-posed as initial-value problems (IVPs). Real-valued characteristics are necessary but not sufficient to insure well-posedness. In the absence of lower order source or sink terms (potential type flows), which can affect the well-posedness of IVPs, the complex characteristics associated with these two-phase flow equations imply unbounded exponential growth for disturbances of all wavelengths. Analytical and numerical examples show that the ill-posedness of IVPs for the two-phase flow partial differential equations which possess complex characteristics produce unstable numerical schemes. These unstable numerical schemes can produce apparently stable and even accurate results if the growth rate resulting from the complex characteristics remains small throughout the time span of the numerical experiment or if sufficient numerical damping is present for the increment size used. Other examples show that clearly non-physical numerical instabilities resulting from the complex characteristics can be produced. These latter types of numerical instabilities are shown to be removed by the addition of physically motivated differential terms which eliminate the complex characteristics. (auth)

2935 (NP-20711) STUDY OF THE RATES OF HEAT TRANSFER AND BUBBLE SITE DENSITY FOR NUCLEATE BOILING ON AN INCLINED HEATING SURFACE. Bonamy, S. E.; Symons, J. G. (New South Wales Univ., Wollongong (Australia). Wollongong Univ. Coll.). Aug 1974. 25p. Dep. NTIS (US Sales Only) $4.25.

Nucleate pool boiling of distilled water from an electrically heated surface at atmospheric pressure was studied for varying heating surface inclinations. The constants of the accepted boiling equation $\phi = K T^5$ and the Rohsenow Correlation Coefficient were found to be dependent on surface orientation. Convection cooling was observed to play a major role in pool boiling phenomena and causes large changes in the heat transfer rates for a given excess of temperature of the heated surface. Active nucleation site density was studied and found to be independent of surface inclination. Empirical relations are presented to provide an understanding of the effects of inclination on other boiling parameters. (auth)

2936 FORCED CONVECTION HEAT TRANSFER WITH TWO-PHASE FLOW. Williamson, K. D. Jr.; Edeskuty, F. J. (Los Alamos Scientific Lab., NM). pp 261-278 of Heat Transfer at Low Temperatures. Frost, W. (ed.). New York; Plenum Publishing Corp. ([nd]).

A number of correlations to represent forced convection heat transfer to two-phase cryogenic fluids are presented. In most cases these were developed from limited data for a single fluid (most often hydrogen). Only one critical evaluation and comparison was made. It should be noted that this evaluation is based only on hydrogen data and that the nucleate boiling portion is based on only 19 data points. Specific recommendations for general use of the equations have not been made because of a lack of generality in their development and the paucity of data. To determine the applicability of any of these correlations with fluids other than those for which they were developed, much more data are required. For cryogens, this should include liquefied methane (liquefied natural gas) nitrogen, oxygen, and helium. While liquid nitrogen and liquid oxygen are already common engineering materials, the rapid growth of the technology of liquefied natural gas and liquid helium presents a real need for more engineering data. (LCL)

2937 COMPOSITE HEAT TRANSFER IN A PIPE WITH THERMAL RADIATION OF TWO-DIMENSIONAL PROPAGATION: IN CONNECTION WITH THE TEMPERATURE RISE IN FLOWING MEDIUM UPSTREAM FROM HEATING SECTION. Echigo, R.; Hasegawa, S.; Kamiuto, K. (Kyushu Univ., Fukuoka). Int. J. Heat Mass Transfer; 18: No. 10, 1149-1159(Oct 1975).

An analytical procedure is presented for simultaneous convective and radiative heat transfer with a fully developed laminar flow in a pipe by taking account of the two-dimensional propagation of radiative transfer and also shows the numerical results on the temperature profiles and the heat-transfer characteristics. In order to solve the energy equation with two-dimensional radiative transfer, the entire ranges of the temperature field have to be solved simultaneously, both along the radial and flow directions. Moreover, the heat flux by thermal radiation emitted from the heating wall propagates upstream so that it is necessary to examine the temperature profiles of the flowing medium to a certain distance upstream from the entrance of the heating section. In this way, in order to attempt to solve the governing equation numerically by a finite difference method, the dimension of matrix becomes extremely large provided that a satisfactory validity of numerical calculation is required. Consequently the band matrix method is used and the temperature profiles of the medium in both regions upstream and downstream from the entrance of the heating section are illustrated and the heat-transfer results are discussed in some detail by comparing with those of the one-dimensional transfer of radiation. (auth)

2938 FRICTION CORRELATIONS FOR RECTANGULAR ROUGHNESS. Baumann, W.; Rehme, K. (Kernforschungszentrum, Karlsruhe, Ger.). Int. J. Heat Mass Transfer; 18: No. 10, 1189-1197(Oct 1975).

A relation for the roughness parameter R of the velocity profile in a fully rough flow is established as a function of the geometrical parameters of the roughness elements. The evaluation is based on a detailed analysis of experimental results described in the literature. Numerous data of friction factors and velocity profiles in channels with artificial rectangular wall roughnesses were taken into account. The geometrical parameters are the ratio of distance to height, the ratio of height to width of the roughness, and the ratio of the height of the roughness to the length of the velocity profile from the rough wall to the position of zero shear stress. Application of the relation determined in this way, which holds over a very broad range of geometrical parameters, allows the pressure drop to be calculated with a rather good accuracy in channels with rectangular wall roughnesses. (auth)

2939 TEMPERATURE-CONTROLLED BOILING HEAT TRANSFER. Sakurai, A. (Kyoto Univ., Uji (Japan). Inst. of Atomic Energy). Kyoto Daigaku Genshi Enerugi Kenkyusho Iho; 46: 1-11(Sep 1974). (In Japanese)

In boiling curves, there is an unstable region which is called the transition boiling region. The heat transfer function for a heat-generating body was obtained from heat conduction theory using a Laplace transformation, and a high-speed analog computer was used to control electric current for a boiling apparatus. The maximum and minimum values of the heat flux during the transient boiling were similar to previous results. Hysteresis phenomenon was observed in nucleate boiling region; inactive bubbling nuclei were activated by seeded vapor from surrounding bubbling nuclei during transition from natural convection to nucleate boiling. The maximum heat flux at the upper limit of nucleate boiling does not coincide with that of the upper limit of transition boiling, so that the hysteresis exists around the maximum heat flux. A local temperature measurement of the heat generating body indicated that unstable nucleate boiling and film boiling exist in a spatially mixed state on the heating body axis in transition boiling. The spatial ratio of the film boiling decreased with decreasing temperature of the heating body. The minimum heat flux was larger than theoretically determined values. (JA)

2940 BURNOUT WHEN BOILING SALT WATER IN TUBES. Yusufova, V. D.; Bronshtein, A. I.; Ugrekhelidze, G. P. Therm. Eng. (USSR) (Engl. Transl.); 21: No. 10, 115-118(1974).

Translated from Teploenergetika; 21: No. 10, 82-84(1974).

Results of an experimental investigation of burnout with boiling water solutions of NaCl and of softened water from the Caspian Sea with an overall salt content from 0 to 160 g/l are presented. Samples of softened sea water were taken from the thermochemical water softening plant of No. 2 heat and power station at Krasnovodsk. Solutions of common salt were prepared in doubly distilled water from a D-2 laboratory distiller. The investigation was carried out on a circulation-type plant into which experimental sections made of stainless steel tubes 7.23 mm in diameter and 730, 800 and 1000 mm in length were connected. The experiments were carried out with rising motion of the flow. The majority of experiments were conducted in series at pressures of 29.4, 58.8, 98 and 147 bar and at mass velocities of 680 and 1000 kg/(m^2/s). The invariable parameters were the initial salt content of the solution, pressure and mass velocity, while enthalpy of the medium at the inlet and heat input in the working section changed. A series of experiments was also carried out in which direct study was made of the influence of mass velocity and pressure on the value of the critical heat flux. 1400 experimental points were obtained. It was determined that for boiling of solutions of salts, the boundary steam content is independent of specific heat flux; is dependent on pressure and on salt content; and decreases with an increase in mass velocity at constant pressure and constant salt content. (LCL)

Materials Testing

Refer also to abstracts 3043 and 4860.

2941 (DP-MS-75-86) NEUTRON RADIOGRAPHIC DETECTION LIMITS OF FLUIDS IN METAL PIPES. Winn, W. G. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1975. Contract AT(07-2)-1. 29p. (CONF-751016-4). Dep. NTIS $4.50.

From conference of the American Society for Nondestructive Testing, Inc.; Atlanta, Georgia, USA (13 Oct 1975).

Thermal neutron radiography has been used to image thin films of various fluids in thick-walled high-pressure process pipes. A 3.5×10^6 n/(cm^2-sec) thermal neutron beam and standard transfer imaging techniques were used to provide radiographs of the fluid-bearing pipes. In addition, a computer graphics procedure was developed which simulated the neutron radiographs; this method permitted examination of some fluid-pipe configurations not studied experimentally. Actual pipe outer dia ranged from 1/4 to 9/16 in. (OD/ID equals 3), but the graphics method was used for some cases outside this range. Fluids in the thermal cross section rangé 0.29 cm^{-1} less than or equal to SIGMA/sub th//sup f/ less than or equal to 3.47 cm^{-1} were examined for pipes with 0.099 cm^{-1} less than or equal to SIGMA/sub th//sup p/ less than or equal to 1.15 cm^{-1}. For SIGMA/sub th//sup f/ greater than SIGMA/sub th//sup p/, the smallest measured film thickness t/sub s/ varied 0.006 to 0.040 in. with decreasing SIGMA/sub th//sup f/; a semiempirical model described t/sub s/ equals t/sub r/ + t/sub a/, where t/sub r/ corresponded to resolution and t/sub a/ depended on the bulk attenuation strength of the fluid. For SIGMA/sub th//sup f/ less than SIGMA/sub th//sup p/, part of the fluid film t/sub m/ was masked by the pipe. The calculated physical film thickness t/sub p/ equals t/sub a/ + t/sub m/ ranged from 0.003 to 0.035 in. for smallest detected fluid films. Detection of low SIGMA/sub th/ fluids was improved as much as 60 percent when the pipes were tilted 60^0 toward the neutron beam. Other options for improved detection were investigated using simulated radiographs. (auth)

2942 (NP-20616) INSPECTION OF NUCLEAR REACTOR WELDING BY ACOUSTIC EMISSION. 1st Interim Report. Prine, D. W.; Clark, R. N. (General American Transportation Corp., Niles, Ill. General American Research Div.). May 1975. 33p. NRC, Washington, DC.

The goal of the first phase of a 3-year research program is to show feasibility and develop equipment design parameters for real time production monitoring of nuclear power piping welding by acoustic emission. The project work to date is discussed. This work includes the incorporation of GARD equipment into a field-portable acoustic emission weld monitor, performance of one "calibration" field test, and one production field test. The calibration field test consisted of 96 weld passes, some of which were intentionally flawed, and all of which were monitored and recorded for laboratory study. The production field tests consisted of 17 multi-pass welds on actual production pieces. The welding in both tests was performed at Southwest Fabricating and Welding Corporation, an N-stamp pipe fabricating facility. The welding monitored was standard nuclear practice using code-approved materials for the calibration work. The production welding was on actual code-certified pipe. Calibration data on 20 multi-pass welds (96 weld passes) showed 7 classes of weld types, 1 with excellent to very good acoustic emission detection properties, 2 with very good properties, 1 with good properties, and 4 that need further study. No weld type has proven to be completely without some acoustic emission monitorability. The production tests have not been completely analyzed; initial analysis show results in line with the calibration data. (auth)

2943 (ORNL-5074) NONDESTRUCTIVE TESTING DEVELOPMENT QUARTERLY PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1975. Hill, M. R. (comp.). (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 44p. AT.

Progress during the period from April to July 1975, in the development of nondestructive testing methods at Argonne National Laboratory, Hanford Engineering Laboratory, and the Oak Ridge National Laboratory is reported. These methods include ultrasonic, radiographic, eddy current, acoustic emission, and thermal and electro-thermal testing. Applications include the inspection of fuel pins, heat exchanger tubing, fuel cladding, welded joints, etc. (LCL)

2944 THE UTILIZATION OF MECHANICAL IMPEDANCE IN ANALYZING THE DYNAMIC BEHAVIOR OF STRUCTURES. Application to Weld Testing. Manaranche, J. C. (CEA Centre d'Etudes de Vaujours, 93 - Sevran (France)). pp 21 of Mechanical Impedance Symposium: Theoretical Expression, Measurement and Utilization. Lyon, 9-10 May 1972. Ecully France; Ecole Centrale de Lyon ([nd]). (In French).

From mechanical impedance symposium: theoretical expression, measurement and utilisation; Lyon, France (9 May 1972).

A method of weld testing by mechanical impedance is described in which the assemblies to be tested, comprising by their construction a coupling flange drilled with holes, are coupled at this point to a conventional exciter and impedance head system by an adaptor. The method was applied to real claddings on which gradual welding had been done from a simple socketed configuration to complete welding. The results achieved are discussed. (FR)

2945 PROBE TRAIN INCLUDING A FLAW DETECTOR AND A RADIATION RESPONSIVE RECORDING MEANS WITH ALIGNMENT MEANS HAVING A NATURAL CURVED CAST. Stone, R. M. (to Combustion Engineering, Inc.). US Patent 3,906,358. 16 Sep 1975. Filed Date 12 Nov 1973. 18p.

An inspection system for a multitube steam generator comprising a probe train for insertion in a tube to be inspected is described. The probe train includes, in series, directional probe means, such as an eddy current probe, for indicating the longitudinal and angular location of an irregularity at or in the wall of the tube, and radiation responsive recording means nonrotatable relative to the eddy current probe during operation and in substantially close longitudinal relationship thereto for receiving an image of the irregularity when laterally adjacent thereto; elongated alignment means joined to at least one end of the probe train against rotation relative thereto and insertable in the tube for controlling or determining the angular orientation of the probe train within the tube; means for propelling the probe train longitudinally within the tube; and a source of radiation insertable in another tube of the steam generator to a position therealong laterally adjacent the indicated irregularity for irradiation of the irregularity to project said image on the recording means. The directional probe means may preferably be an eddy current probe and the radiation responsive recording means may preferably be a film bearing cassette probe. The alignment means may be provided by a resilient naturally curved plastic cable, which cable might also be used to propel the probe train. (auth)

2946 NON-DESTRUCTIVE TESTING BY MEANS OF RADIATION. Kamio, A. (Ship Research Inst., Tokyo (Japan)). Kinzoku Zairyo; 14: No. 11, 92-96(Nov 1974). (In Japanese)

Better radiographic tests are achieved with high defect image contrast, but the penetrating capability of radiation and the contrast are in incompatible relation. As a result, radiographic equipment ranges from soft x-ray machines to high energy x-ray generators. X-ray films affect the image contrast and the degree of granularity. The effect of sensitizing sheets is also large, and lead-foil sensitizing sheets are generally employed. High energy x-ray generators used for industrial radiography are betatrons and linacs. Gamma-ray radiographic testing uses radioisotopes as sources, mainly ^{60}Co and ^{192}Ir, but sometimes ^{137}Cs and ^{170}Tm. Since x-ray films affect image quality, it is necessary to use high contrast films with fine, uniform grains and to select the appropriate range of radiation quality. For the radiation energy range suitable for the thickness of test samples, the degree of discrimination must be determined with penetrometers. Recently, monitoring with x-ray TV fluoroscopes and neutron radiography with thermal neutrons have been started. (JA)

2947 STATUS OF NON-DESTRUCTIVE INSPECTION TECHNIQUES WITH SPECIAL REFERENCES TO WELDING DEFECTS. Packman, P. F. (Vanderbilt Univ., Nashville, Tenn. (USA)). pp 9-21 of Significance of Defects in Welded Structures. Kanazawa, T. (Tokyo Univ. (Japan). Faculty of Engineering); Kobayashi, A. S. (eds.). Tokyo, Japan; University of Tokyo Press (1974).

From Japan-U.S. seminar on significance of defects in welded structures; Tokyo, Japan (15 Oct 1973).

The state of the art of nondestructive inspection techniques (NDT), including weld defect detection and size discrimination, is reviewed, and minimum flaw detection capability and flaw criticality measurement by NDT are summarized. The use of fracture mechanics as a design analysis technique has altered the nature of NDT, and NDT processes must be optimized, and the reliability of detection capability for small flaw size improved. The quantitative aspects of NDT are yet in rudimentary stage. (JA)

2948 X-RAY STRESS MEASURING INSTRUMENT. Shimura, Y. (to Rigaku Denki Co. Ltd., Tokyo (Japan)). Japanese Patent 1974-19239/B/. 7 Mar 1969. 4p. (In Japanese)

An x-ray stress measuring instrument was designed, having an electron emissive cathode at the center of the x-ray tube head, two targets at the inner sides of an airtight tube wall opposing the cathode, and two x-ray detectors arranged outside the targets. X-ray beams from the two targets are brought into incidence at a position on the specimen, one beam perpendicular, the other at a desired angle. The two detectors are moved simultaneously on a circular arc around the point of incidence within a plane containing the point of incidence as well as the two targets, and

the difference between the angles of diffraction is evaluated. Using two targets rather than the convention single target enhances measurement efficiency, and the angle between the incident x-ray beam and the diffracted x-ray can be greatly reduced to increase precision. (JA)

Nuclear Explosions

Refer also to abstracts 2980, 2984, 2985, 3029, 3075, 3121, 3682, and 4451.

2949 (AWRE-Trans-69) FRENCH AND RUSSIAN PRESENTATIONS TO THE MEETING OF THE INTERNATIONAL ATOMIC ENERGY AGENCY'S TECHNICAL COMMITTEE ON THE PEACEFUL USES OF NUCLEAR EXPLOSIONS, VIENNA, 20-24 JANUARY 1975. May 1975. Translated by W. E. Jones. (CONF-750109-10). 105p. Dep. NTIS $5.45.

From 4th IAEA panel on peaceful nuclear explosives; Vienna, Austria (20 Jan 1975).

The national statements by France and the USSR on peaceful uses of nuclear explosions and six technical papers on the subject are reported. A separate abstract was prepared for each of these eight items. (LCL)

For abstracts of individual papers see: 2950–2957.

2950 (AWRE-Trans-69, pp 4-5) FRENCH NATIONAL STATEMENT. Sarcia, A. J. May 1975. Translated by W. E. Jones from a French Paper.

From 4th IAEA panel on peaceful nuclear explosives; Vienna, Austria (20 Jan 1975).

In French and Russian presentations.

The program of the CEA (France) for studying peaceful uses of contained underground nuclear explosions, particularly uses in the field of petroleum and gas recovery and storage is outlined. This program includes economic studies, theoretical studies, and technical research. (LCL)

2951 (AWRE-Trans-69, pp 6) SOVIET NATIONAL STATEMENT. Myasnikov, K. V. May 1975. Translated by W. E. Jones from a Russian Paper.

From 4th IAEA panel on peaceful nuclear explosives; Vienna, Austria (20 Jan 1975).

In French and Russian presentations.

The Soviet Union's national program for research on peaceful uses of underground nuclear explosions is outlined. (LCL)

2952 (AWRE-Trans-69, pp 7-41) APPLICATION OF CONTAINED NUCLEAR EXPLOSIONS FOR CREATING UNDERGROUND RESERVOIRS AND TESTING THEIR OPERATION FOR THE STORAGE OF GAS CONDENSATE. Kedrovskii, O. L.; Myasnikov, K. V.; Leonov, A. E.; Romadin, N. M.; Borodnev, V. F.; Nikoforov, G. A. May 1975. Translated by W. E. Jones from a Russian Paper.

From 4th IAEA panel on peaceful nuclear explosives; Vienna, Austria (20 Jan 1975).

In French and Russian presentations.

Investigations on the creation of underground reservoirs by means of nuclear explosions have been going on in the Soviet Union for many years. Three main sites or formations that can be used for constructing reservoirs by this method are considered, namely low permeable rocks, worked-out reservoirs and rock salt formations. Formulas are given for predicting the mechanical efforts of an explosion in rocks, taking their strength characteristics into account. Engineering procedures are described for sealing and restoring the emplacement holes, so that they can be used for operating the underground reservoir. Experience with the construction and operation of a 50,000 m^3 gas condensate reservoir in a rock salt formation is described. A method for calculating the stability of spherical cavities created by nuclear explosions in rock salt, allowing for the development of elasto-plastic deformations, and creep, is presented. (auth)

2953 (AWRE-Trans-69, pp 42-63) MULTIPLE NUCLEAR EXPLOSIONS FOR EXCAVATION IN ALLUVIAL ROCKS. Kireev, V. V.; Kedrovskii, O. L.; Valentinov, Yu. A.; Myasnikov, K. V.; Nikoforov, G. A.; Prozorov, L. B.; Potapov, V. K. May 1975. Translated by W. E. Jones from a Russian Paper.

From 4th IAEA panel on peaceful nuclear explosives; Vienna, Austria (20 Jan 1975).

In French and Russian presentations.

The first nuclear explosion in alluvial rocks for excavation, carried out on the route of the Pechora-Kolva canal is described. The purpose of the explosions is explained, the geological conditions, yields and emplacement parameters of the charges are presented and the overall pattern and data on the dynamics of development of the explosion are given. Information on the seismic action of the explosion is included. The parameters are given for the trench-excavation formed and the characteristics of the rock ejecta. A conclusion is drawn about the feasibility of producing large-scale engineering excavations suitable for hydrotechnological purposes by means of nuclear explosions in a thick stratum of weak water-bearing rocks. (auth)

2954 (AWRE-Trans-69, pp 64-70) EVALUATION OF THE POSSIBLE RESIDUAL STRESSES IN A ROCK MASSIF AFTER AN EXPLOSION. Rodionov, V. N.; Sizov, I. A.; Tsvetkov, V. M. May 1975. Translated by W. E. Jones from a Russian Paper.

From 4th IAEA panel on peaceful nuclear explosives; Vienna, Austria (20 Jan 1975).

In French and Russian presentations.

The effect of the stressed state of the unbroken mass left behind after an explosion is considered for different media. An evaluation is made of possible residual stresses and their distribution in the zones of elastic and inelastic deformation. The process of self-propagation of an explosion in an inhomogeneous anisotropic medium or in a medium with an inhomogeneous stress field is also considered. (auth)

2955 (AWRE- Trans-69, pp 71-81) MODEL STUDY ON THE CRUSHING EFFECT OF AN EXPLOSION. Lukishov, B. G.; Rodionov, V. N.; Sizov, A.; Tsvetkov, V. M. May 1975. Translated by W. E. Jones from a Russian Paper.

From 4th IAEA panel on peaceful nuclear explosives; Vienna, Austria (20 Jan 1975).

In French and Russian presentations.

Experimental data on the crushing of rosin blocks under shock compression are reported. It is shown that crushing of the material takes place at the wave front in the shock-wave amplitude range of 6 to 25 kbar, and that the destruction front begins to lag behind the wave front when the wave amplitude falls below 6 kbar, while still retaining a steady propagation velocity down to 2 kbar. The observed type of destruction, propagated as a crushing front, is thought likely to play a decisive role as the scale of the explosion increases. (auth)

2956 (AWRE-Trans-69, pp 82-93) DIFFUSION AND DEPOSITION OF RADIOACTIVE PRODUCTS FROM THE CLOUD OF AN UNDERGROUND NUCLEAR EXPLOSION. Izrael, Yu. A.; Petrov, V. N. May 1975. Translated by W. E. Jones from a Russian Paper.

From 4th IAEA panel on peaceful nuclear explosives; Vienna, Austria (20 Jan 1975).

In French and Russian presentations

Schemes for calculating the diffusion and deposition of radioactive products from the cloud of an underground cratering nuclear explosion in the intermediate zone and at large distances from the epicenter are discussed. Schemes are discussed which permit the fallout density of individual radioisotopes to be calculated as a function of distance, both for dry and wet deposition. (auth)

2957 (AWRE-Trans-69, pp 94-104) POSSIBLE TECHNICAL APPROACHES TO DEVELOPING SAFETY STANDARDS FOR CARRYING OUT PEACEFUL NUCLEAR EXPLOSIONS. Grechushkina, M. P.; Izrael, Yu. A.; Petrov, V. N. May 1975. Translated by W. E. Jones from a Russian Paper.

From 4th IAEA panel on peaceful nuclear explosives; Vienna, Austria (20 Jan 1975).

In French and Russian presentations.

It is proposed that radioactive fallout at great distances from the explosion center, where large numbers of people may reside and be exposed to minute doses of irradiation, should be taken into account in establishing safety standards for nuclear cratering explosions. As far as the technical approach to the establishment of such standards is concerned, it is suggested that the maximum permissible doses adopted should be some small fraction of the genetic dose and critical organ doses recommended by the ICRP, and a small fraction of the dose from natural radiation. Moreover, fallout of the long-lived nuclides 90-Sr and 137-Cs should not lead to any increase in the 90-Sr and 137-Cs levels already present because of nuclear weapons tests in the past; on the contrary, the trend towards a reduction of those levels should continue. Present radiation conditions and some problems of predicting radioactive fallout at large distances are considered. It is shown that the use of explosive charges commensurate with present technology would allow certain projects requiring nuclear cratering explosions to be carried out under satisfactory conditions from the standpoint of radiation protection. (auth)

2958 (UCID-16894) EQUALIZING CABLE TO TRANSMIT WIDEBAND PULSE-LIKE, AND RISING EXPONENTIAL ANALOG WAVEFORMS: A NEW SURVEY. Bukofzer, D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 24 Sep 1975. Contract W-7405-Eng-48. 59p. Dep. NTIS $5.50.

The problem of transmitting wideband analog waveforms through cable systems is examined. Classes of analog waveforms are defined, cables are modeled, and a cable measurement system that generates equalization data is described. Errors that occur at the output of cable systems, and bounds on these errors, are analyzed. System improvements, which could be implemented provided certain technological developments take place, are discussed. Suggestions for such improvements are presented in the form of short informal proposals that could be expanded into formal proposals at a later date. (auth)

2959 POKHRAN EXPERIMENT: SOME POSSIBLE USES. Nucl. India; 13: No. 10, 2-3; (7 Jun 1975).

From 11th founder memorial lecture of the Shriram Inst. for Industrial Research; New Delhi, IN (26 Apr 1975).

The Pokhran experiment, an underground nuclear explosion detonated in the Rajasthan Desert in order to study fracturing effects in rocks, ground-motion, containment of radioactivity and the problems involved in post-shot access, was a dramatic projection of India's capability in the technology of nuclear explosions. The experiment, its environmental effects and some of the possible uses to which such explosions could be put to for economic benefit are discussed. (auth)

2960 STATISTICAL ANALYSIS AND INTERPRETATION OF SURFACE-WAVE ANELASTIC ATTENUATION DATA FOR THE STABLE INTERIOR OF NORTH AMERICA. Herrmann, R. B.; Mitchell, B. J. (St. Louis Univ.). Bull. Seismol. Soc. Am.; 65: No. 5, 1115-1128(Oct 1975).

As a byproduct of determining the source characteristics of some earthquakes and underground nuclear explosions, a body of fundamental-mode Rayleigh- and Love-wave anelastic attenuation values is available for propagation paths in the stable interior of North America in the 5- to 50-sec-period range. The anelastic attenuation values were obtained from four earthquakes occurring in the New Madrid seismic region, one earthquake in the northern Hudson Bay region, and three underground nuclear explosions in the western United States. In obtaining the anelastic attenuation data, a simple statistical test was applied to test the reliability of the observations. The anelastic attenuation coefficients are presented together with their 95 percent confidence levels. A stochastic form of the Backus-Gilbert inverse formalism was applied to a subset of these data to yield a Q/sub beta/ model for the stable interior of North America. The model is characterized by relatively low Q/sub beta/ values for the upper crust and a rapid transition to much higher values for the lower crust. (auth)

2961 RIO BLANCO EXPERIMENT: ITS OBJECTIVES, DESIGN, AND EXECUTION. Luetkehans, G. R. (CER Geonuclear Corp., Las Vegas, NV); Toman, J.; DiBona, B. G. Nucl. Technol.; 27: No. 4, 539-558(Dec 1975).

Project Rio Blanco is a joint government-industry experiment utilizing nuclear explosives to stimulate gas production from thick, relatively impermeable, gas-bearing lenticular sand and shale sequences. Three 30-kt explosives spaced vertically in a single wellbore at intervals of 390 and 460 ft were detonated simultaneously on May 17, 1973. No significant adverse effects were experienced, and damage resulting from ground motion was as predicted. The initial reentry into the upper explosive region indicates that coalescense of the top cavity and fracture region with the lower ones did not occur as expected. Reentry into the bottom cavity indicated that similarly, communication does not exist between the lower two chimneys. The fracture height of the upper region was about as predicted from previous experience with single-chimney geometry as was the cavity radius resulting from the bottom detonation. All indications are that yields were as predicted, and to date there is no valid explanation as to the lack of intercommunication between the fracture regions of the three explosives. Production test data from the top chimney indicated a reservoir capacity of only 0.73 md-ft, which is 6 to 10 times lower than expected. Subsequent testing of an evaluation well and other data lends further evidence that, although significant stimulation most surely occurred, the gas contained in the sandstones was much less than had been originally anticipated. Properties deduced from production test data from the bottom chimney are in much better agreement with predetonation estimates. Further investigations are required to fully evaluate the experiment. (auth)

2962 RIO BLANCO: NUCLEAR OPERATIONS AND CHIMNEY REENTRY. Woodruff, W. R.; Guido, R. S. (Univ. of California, Livermore). Nucl. Technol.; 27: No. 4, 559-622(Dec 1975).

Rio Blanco was the third experiment in the U.S. Atomic Energy Commission's Plowshare Program to develop technology to stimulate gas production from geologic formations not conducive to production by conventional means. The project was sponsored by CER Geonuclear Corporation, with the Lawrence Livermore Laboratory providing the explosives and several technical programs, such as spall measurement. Three nuclear explosives specifically designed for this application were detonated simultaneously in a minimum-diameter emplacement well using many commercially available but established-reliability components. The explosive system performed properly under extreme temperature and pressure conditions. Emplacement and stemming operations were designed with the aim of simplifying both the emplacement and reentry and fully containing the detonation products. An integrated command and control system was used with communication to all three explosives through a single coaxial cable. Reentry and the initial production testing are completed. To date 98 million standard ft^3 of chimney gas have been produced. (auth)

2963 MODIFICATION OF THE COLONY TOWER FOR THE RIO BLANCO DETONATION. Blume, J. A.; Freeman, S. A.; Honda, K. K.; Lee, L. A. (URS/John A. Blume and Associates, Engineers, San Francisco). Nucl. Technol.; 27: No. 4, 623-630 (Dec 1975).

Supplemental structural bracing was designed and installed for the 180-ft-tall Colony Tower, an experimental oil shale processing retort structure, in anticipation of its lateral response to the Rio Blanco detonation. The tower is a steel structure with both horizontal and vertical diagonal bracing. Data obtained from the earlier Project Rulison detonation indicated that an evaluation study was necessary. Design criteria that would provide an adequate margin of safety were developed based on predicted Rio Blanco ground motion. The evaluation of the unmodified structure showed that several bracing members would be subjected to forces exceeding their yield strength, and some would reach a level at which failure could occur. Further analyses were made with assumed modified bracing members. A final scheme for modified vertical bracing was established and installed. After modification, the response of the tower during the Rio Blanco detonation was measured by instruments on the ground and at various locations on the tower, and no evidence of damage was discovered. The modification of the Colony Tower and the procedures used to determine these modifications show the usefulness of current ground motion and structural response prediction technology for forecasting dynamic behavior of important structures subjected to ground motion from underground nuclear explosions. (auth)

2964 PROJECT RIO BLANCO GROUND MOTION STUDIES. Alcock, E. D. (CER Geonuclear Corp., Las Vegas, NV). Nucl. Technol.; 27: No. 4, 631-639(Dec 1975).

A major instrumentation program was undertaken for the Rio Blanco experiment to measure the ground motion at various azimuths and distances from the emplacement well. Another instrumental array was fielded to detect the change, if any, in the seismicity of the area due to the experiment, and to detect and locate the hypocenters of the aftershocks. The various effects of the ground motion were less than the predetonation predictions. The postdetonation damages paid to date are $57,872 as compared to the predetonation prediction of $51,300 +- $13,200 for low-rise structures alone. (auth)

2965 RIO BLANCO EXPERIMENT: SUBSURFACE AND SURFACE EFFECTS AND MEASUREMENTS. Toman, J.; Sisemore, C.; Terhune, R. (Univ. of California, Livermore). Nucl. Technol.; 27: No. 4, 640-652(Dec 1975).

A major instrumentation program undertaken in the Rio Blanco experiment involved the burial of 20 accelerometers and 16 velocity gauges at varying depths from the ground surface and distances from the emplacement well. The objective was to measure the extent of spall (tensile failure of the earth materials). A preliminary analysis of the accelerometer data indicates that the Rio Blanco spall zone can be described as a broad shallow dish with a most probable depth of less than 350 ft and a radius of less than 24,000 ft. Spalled material experiences a period of free fall (-1-g acceleration) that can be identified in both acceleration and velocity traces. Acceleration records show conclusively that spall occurred above 149 ft at the emplacement well, but not below 604 ft. Instruments placed at depths of 350 and 450 ft appear not to have recorded spall characteristics, but these records must be analyzed in greater detail for a definitive statement. The results are in general agreement with predetonation predictions. (auth)

2966 HEATING EFFECTS IN RIO BLANCO ROCK. Taylor, R. W.; Bowen, D. W.; Rossler, P. E. (Univ. of California, Livermore). Nucl. Technol.; 27: No. 4, 653-659(Dec 1975).

Samples of "sandstone" from near the site of the upper Rio Blanco nuclear explosion were heated in the laboratory at temperatures between 600 and 900°C. The composition and amount of noncondensable (dry) gas released were measured and compared to the amount and composition of gas found underground

following the explosion. The gas released from the rock heated in the laboratory contained approximately 80 percent CO_2 and 10 percent H_2; the balance was CO and CH_4. With increasing temperature, the amounts of CO_2, CO, and H_2 released increased. The composition of gas released by heating Rio Blanco rock in the laboratory is similar to the composition of gas found after the nuclear explosion except that it contains less natural gas (CH_4, C_2H_6 . . .). The amount of noncondensable gas released by heating the rock increases from approximately 0.1 mole/kg of rock at 600°C to 0.9 mole/kg at 900°C. Over 90 percent of the volatile components of the rock are released in less than 10 h at 900°C. A comparison of the amount of gas released by heating rock in the laboratory to the amount of gas released by the heat of the Rio Blanco nuclear explosion suggests that the explosion released the volatile material from about 0.42 mg of rock per joule of explosive energy (1700 to 1800 tonnes per kt). (auth)

2967 PORE PRESSURE ENHANCEMENTS OBSERVED ON RIO BLANCO. Banister, J. R.; Ellett, D. M. (Sandia Labs., Albuquerque, NM). Nucl. Technol.; 27: No. 4, 660-679(Dec 1975).

Measurements were made of the change of in situ pore pressures and the associated accelerations in the saturated clayey silts (ML) of Fawn Creek and Black Sulphur Valleys at 2.1, 4, 7, and 10 km from surface zero. The early pore pressure changes correlated well with accelerations while the later values correlated better with velocities. The pressure changes ranged from 17.1 to 0.36 psi for the peak pressures and from 1.7 to 0.10 psi for the average pressure increases 10 sec after the detonation. Pretest estimates indicated that liquefaction was considered probable but it was not observed and the pore pressure increases were one-quarter or less than those associated with this phenomenon. (auth)

2968 VERIFYING THE COHERENCY TRANSFER FUNCTION GROUND MOTION PREDICTIONS FOR MULTIPLE UNDERGROUND EXPLOSIONS. Power, D. V. (El Paso Natural Gas Co., TX). Nucl. Technol.; 27: No. 4, 680-691(Dec 1975).

The coherency transfer function (CTF) is a method for summing seismograms from multiple nearly coherent sources by using a frequency domain transformation. Ground motion predictions for the nuclear explosive Rio Blanco experiment are calculated for peak vector amplitudes of acceleration, velocity, and displacement and are compared to the Rio Blanco data and the results of other prediction techniques. Predictions of amplitudes are higher than experimental results by a few percent for acceleration and displacement and by 20 percent for velocity. Data regression slopes are approximately 12 percent greater than predicted values for acceleration but less than 5 percent greater for displacement and velocity. CTF predictions are found to agree with experimental results as good as or better than values predicted by other methods. (auth)

2969 PRODUCTION TEST DATA AND PRELIMINARY ANALYSIS OF TOP CHIMNEY/CAVITY. Toman, J. (Univ. of California, Livermore). Nucl. Technol.; 27: No. 4, 692-704 (Dec 1975).

The reentry drilling established communication with the top Rio Blanco detonation region at a depth of 1704 m, or approximately 76 m above the top detonation center. A total of 2.8×10^6 m^3 (98×10^6 ft^3) of dry gas at standard conditions has now been produced during two separate test periods. Radioactive and chemical analysis of this gas and the modeling of the stimulated reservoir show the following main results: 1. No permeable connection exists between the top and the middle detonation regions, since no significant amount of the tracer incorporated in the center explosive canister was detected in the produced gas. As a consequence, results for the top detonation region only are available at this time. 2. The initial cavity radius is deduced to be 20 m (66 ft) or well within expectations. 3. Integration of the ^{85}Kr produced indicates a yield of 34 ± 3 kt for the top explosive. 4. Of the approximately 1000 Ci of tritium produced in the top explosion region, approximately 5 percent is incorporated in the gas phase. 5. Pressure drawdown and buildup data are best reproduced by a two-layer reservoir model showing stimulated permeabilities approximately 10 and 30 times original formation permeabilities, and extending to a distance of approximately 3 cavity radii from the wellbore. 6. The capacity of the reservoir intercepted by the top explosive is deduced to be approximately 0.2 millidarcymeters (md-m) [0.73 millidarcy-feet (md-ft)], as contrasted with preshot estimates ranging from 1.3 md-m (4.1 md-ft) to 2.3 md-m (7.6 md-ft). Additional subsurface investigations of the other detonation regions, as well as a reevaluation of the initial reservoir properties, are in progress. (auth)

Safety Engineering

2970 METHOD OF PREVENTING HIGH TEMPERATURE LIQUID SODIUM FIRES. Furukawa, K.; Kitani, S.; Yamada, E. (to Japan Atomic Energy Research Inst., Tokyo). Japanese Patent 1974-18327/B/. 28 Jan 1969. 3p. (In Japanese)

A method is presented of extinguishing fires caused by liquid sodium without damaging machines and apparatus in the work area. The method comprises: (1) maintaining a constant environment in the work area (e.g. normal atmospheric pressure, 20°C, and a water vapor content of $12 g/m^3$); (2) providing a reserve space containing an inert gas and water vapor in a quantity equivalent to that of the working space and isolated from it; (3) maintaining the reserve space in a compressed state (e.g. 3 atm.); (4) mixing both gases upon the outbreak of by removing the isolating member; and (5) reducing the oxygen content of the mixed gas to a value in which the sodium is no longer combustible. (JA)

ENVIRONMENTAL AND EARTH SCIENCES

Refer also to abstract 4934.

2971 COMING ENERGY CRISIS AND SOLAR SOURCES. Bockris, J. O. (Flinders Univ. of South Australia, Bedford Park). Environ. Conserv.; 1: No. 4, (Win 1974).

The nature of the present (pseudo) and coming (real) energy crises have been indicated. Recent evidence suggests that pollutive dangers from nuclear fission plants are far greater than had been thought. The resuscitation on a large scale of coal as an energy source would give pollutive dangers, including climatic changes due to excess carbon dioxide. Solar energy systems, earlier impossibly expensive, are now predicted to have the same capital cost-range as have nuclear reactors. Cheap, high-purity silicon coatings which adsorb at $<10^{-4}$cm but do not emit at $>10^{-4}$cm, thin-film photovoltaics, thermoelectrics, and photosynthesis, are areas of immediate solar energy research interest. Rooftop energy collection may be a permanent part of the future, but will not avoid the necessity of large "solar farms" to collect energy for industry and transportation. Storage should be in the form of hydrogen: there are advantages in developing cheap hydrogen as a general and clean fuel, for transportation and other purposes. (auth)

2972 DECAY CHARACTERISTICS OF SOIL THERMOLUMINESCENCE. Nishita, H.; Moore, R. H.; Beckman, R. J.; Hamilton, M. (Los Alamos Scientific Lab. NM). Soil Sci.; 119: No. 4, 259-268(1975).

Thermoluminescent decay of five different types of soils (soil no. 4FF, Yolo sandy loam, Hanford sandy loam, soil no. 9RDG, and Egbert muck) irradiated by Co60 photons and in the reactor were examined. Although the glow output and the glow curve shapes differed considerably among the soils, the shape of the thermoluminescent decay curves, in general, were quite similar, whether the soil was irradiated by Co60 photons or in the reactor. Regardless of the soil type, the most rapid decay occurred within the first 24 hr after irradiation. After the lapse of sufficient decay time, an apparent isothermal equilibrium state was approached. Curves were fitted to the decay data by the use of a computer program which obtains a weighted least squares fit of a function to the data by means of stepwise Gauss-Newton iterations on the parameters. The results indicated that the thermoluminescent decay curves of soils were hyperbolic [Y equals alpha(beta + X)/sup gamma/ + delta] in form. (auth)

2973 SHIFTS IN MICROBIAL GROUPS OF RIVER WATER UPON PASSAGE THROUGH COOLING SYSTEMS. Verstraete, W.; Voets, J. P.; Vanstaen, H. (Univ. of Ghent). Environ. Pollut. (London); 8: No. 4, 275-282(Jun 1975).

Three industrial cooling plants, using river water in a once-through flow pattern at rates ranging from 1·8 to 20 m^3 sec^{-1}, were studied for their possible impact on the microbiota of the cooling water. In spite of the temperature increases, ranging from 5 to 10°C, no drops in cell counts were observed. On the contrary, various microbial groups and particularly E. coli and faecal streptococci populations were magnified by a factor ranging from 1 to 7. In addition, a shift in dominance towards mesophilic and thermophilic micro-organisms was noted and a net in sporulated versus total bacteria observed. Further investigations indicated that these shifts result from the fact that the industrial coolers act as tubular microbial ractors, producing at rapid rates not only aquatic micro-organisms, but also faecal bacteria. (auth)

2974 EFFECTS OF THE DISCHARGE OF THERMAL EFFLUENT FROM A POWER STATION ON LAKE WABAMUN, ALBERTA, CANADA: LIMNOLOGICAL FEATURES. Gallup, D. N.; Hickman, M. (Univ. of Alberta, Edmonton). Hydrobiologia; 46: No. 1, 45-69(1975).

The physical and chemical aspects of Lake Wabamun are described. Modifications to the thermal and dissolved oxygen regimes through the discharge of thermal effluent into the eastern region of the lake are discussed. This discharge has, therefore, changed the environmental conditions under which the biota exists in the eastern portion of the lake. It was also shown that this discharge of heated water had no effect upon the water chemistry while the power station itself contributed silica, in the form of fly ash, to the system. Tables of the phytoplankton, zooplankton, aquatic macrophytes, and fish are provided. From a biological and limnological standpoint the lake can be classified as a moderately eutrophic lake, especially in the eastern portion. (auth)

Minerals and Ores

Refer also to abstract 4919.

2975 (AAEC/IP-5) URANIUM RESOURCES AND REQUIREMENTS. Silver, J. M.; Wright, W. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Aug 1975. 16p. Dep. NTIS (US Sales Only) $4.00.

About 3.5 million tonnes of uranium is estimated to be available to the Western World in deposits which could be recovered for present day costs of less than $A30 per kilogram. There are good prospects for the discovery of further deposits (particularly in Africa, Canada, South America, and Australia) which could extend these resources. Australia has about 19% of the reasonably assured resources of uranium in the Western World recoverable at costs of less than $A20 per kilogram, or about 9% of the resources (reasonably assured and estimated additional) recoverable at costs of less than $A30 per kilogram. Australia's potential for further discoveries of uranium is good. (auth)

2976 RADIOACTIVE AEROSOLS IN URANIUM MINES. Madelaine, Guy (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Protection). pp 203-207 of 8th National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French).

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

The formation and the size distribution of radioactive and non-radioactive particles in uranium mines is developed as well as the behavior of radon and its daughter products. (FR)

2977 URANIUM ORE DEPOSITS: HOW THEY WERE FORMED, WHERE THEY ARE FOUND. World Mining; 40-47 (Jul 1974).

Highlights from the Symposium on the Formation of Uranium Ore Deposits sponsored by IAEA are given. The supply challenge, porphyry uranium deposits and exploration, 16 Ambrosia Lakes, sandstone deposit types, vein deposits, fossil time markers, and uranium in Brazil and Karroo were covered. (LK)

2978 REHABILITATION OF URANIUM MINES TAILINGS AREAS. Vivyurka, A. J. Can. Min. J.; 96: No. 6, 44-45(Jun 1975).

Experiences in treatment of uranium mine tailings in the Elliot Lake, Ontario area are reviewed. Active treatment or rehabilitation is taking place at five of the seven tailings areas. Removal of radium 226 using barium chloride solution is discussed. Experiments with various types of vegetative coverings, soil neutralizers, fertilizers, etc. are also discussed. (JGB)

Radioactivity Monitoring and Transport

Refer also to abstracts 2585, 2957, 2989, 3683, and 3684.

2979 (BNL-tr-611) INVESTIGATION OF THE BEHAVIOR OF TRACE ELEMENTS IN OCEAN WATER BY THE DESORPTION METHOD. Gromov, V. V. Translated from Radiokhimiya; 16: No. 6, 757-760(1975). 14p. Dep. NTIS $4.50.

Studies were conducted on the absorption and desorption of ^{239}Pu, ^{106}Ru, ^{99}Tc, ^{60}Co, and ^{54}Mn in equilibrium with seawater. Equations are developed for absorption and desorption of trace elements by various sorbents. Samples of ocean sediments were contaminated with radioisotopes and desorption was carried out with fresh water. Kd constants of the elements are tabulated for different types of bottom sediments and typical curves of the amounts of different elements present in the carbonate sediment are presented. (HLW)

2980 (BNWL-SA-5505) STATISTICAL DESIGN AND ANALYSIS OF ENVIRONMENTAL STUDIES FOR PLUTONIUM AND OTHER TRANSURANICS AT NAEG "SAFETY-SHOT" SITES. Gilbert, R. O.; Eberhardt, L. L.; Fowler, E. B.; Romney, E. M.; Essington, E. H. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jul 1975. Contract AT(45-1)-1830. 13p. (CONF-751105-6). Dep. NTIS $4.00.

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, California, USA (17 Nov 1975).

This paper is centered around the use of stratified random sampling for estimating the total amount (inventory) of $^{239-240}Pu$ and uranium in surface soil at ten "safety-shot" sites on the Nevada Test Site (NTS) and Tonopah Test Range (TTR) that are currently being studied by the Nevada Applied Ecology Group (NAEG). The use of stratified random sampling has resulted in estimates of inventory at these desert study sites that have smaller standard errors than would have been the case had simple random sampling (no stratification) been used. Estimates of inventory are given for ^{235}U, ^{238}U, and $^{239-240}Pu$ in soil at A Site of Area 11 on the NTS. Other results presented include average concentrations of one or more of these isotopes in soil and vegetation and in soil profile samples at depths to 25 cm. The regression relationship between soil and vegetation concentrations of ^{235}U and ^{238}U at adjacent sampling locations is also examined using three different models. The applicability of stratified random sampling to the estimation of concentration contours of $^{239-240}Pu$ in surface soil using computer algorithms is also investigated. Estimates of such contours are obtained using several different methods. The planning of field sampling plans for estimating inventory and distribution is discussed. (auth)

2981 (BNWL-tr-152) CONTAMINATION OF SOILS. Part 2. Behavior of Radioactive Ions in Unsaturated Soils After Water Disposal into a Limited Surface. Rancom, D. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France)). 7 Oct 1975. Translation by L. Appleby of CEA-R-3635(2). 42p. Dep. NTIS $5.00.

The behavior of water in unsaturated soils after disposal into a limited surface was studied. Results are reported from a study in situ of the contamination of unsaturated soils after discharge into a limited surface, the measurement of the evolution of wetness in the soils being completed by measurement of the movement of radioactive ions in solution in the water. As most of the contaminating elements are more or less retained by the soil constituents, ^{131}I was chosen as the type of element loosely retained and ^{85}Sr was chosen as the element well retained. (CH)

2982 (DPSPU-75-30-8) SURVEY FOR RADIOACTIVITY IN A SWAMP. Johnson, J. E. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Sep 1975. Contract AT(07-2)-1. 11p. (CONF-750967-4). Dep. NTIS $4.00.

From 3rd ERDA environmental protection conference; Chicago, Illinois, USA (23 Sep 1975).

An estimated 25 curies of cesium-137 and less than 1 curie of cobalt-60 were deposited in an offsite swamp below the Savannah River Plant by effluents to site streams during periods of river flooding. Aerial surveys were effective in defining the deposited radioactivity. Ground surveys with portable gamma scintillometers and thermoluminescent dosimeters indicated dose rates generally below 60 mu R/hr with a maximum of 120 mu R/hr. Soil samples contained ^{137}Cs ranging from less than 1 to 525 pCi/g in the top 7.5 cm. Vegetation contained from 1 to 235 pCi/g, and wildlife ranged from less than 1 to 15 pCi/g in edible tissue. A comprehensive ground survey on a three-meter centered grid pattern was conducted on 43 acres in the area of higher readings. No restrictions on use of the swamp are warranted. The swamp will be monitored annually to evaluate possible redistribution of the ^{137}Cs. (auth)

2983 (ERDA-tr-67) CONCLUSIONS DRAWN FROM STUDY OF MIGRATION OF FISSION PRODUCTS. Frejacques, C.; Blain, C.; Devillers, C.; Hagemann, R.; Ruffenach, J. C. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Div. de Chimie). 1975. Translation of SM-204/24. 25p. Dep. NTIS $4.25.

The Oklo fossil reactor is especially interesting and so far unique in the study of migrations of the uranium fission products after an exceptionally long cooling and storage time amounting to 1.8 billion years. The specimens studied are located along a drilling core which passes through a reaction zone. Panoramic analysis by mass spark spectrometry allows qualitatively displaying the curve of fission yields of the different isotopes and observation of abnormalities connected in the beginning with some of them: alkalines, iodine, molybdenum, alkaline-earths. The behavior of certain special elements has been specified by chemical and isotopic analyses. It is shown that the thorium formed by decay of ^{240}Pu and ^{238}U has remained linked to the uranium. The same is true for neodymium, samarium and gadolinium. The majority of the bismuth is also found to be formed by decay of ^{241}Pu and ^{237}U. The majority of the Ru has remained in situ, and a deficit close to 30 percent may be observed in some samples with a part of this attributed to the migration of the technetium 99. Analysis of krypton and xenon shows that the greatest part of these gases has disappeared and that this disappearance began to occur during the nuclear reaction. The magnitude of the storage problem for radioactive wastes produced in nuclear reactors gives an especial interest which is up until this point still unique in the lessons that can be drawn from study of the migration of fission products in the Oklo fossil reactor. (auth)

2984 (TID-26872) ANNUAL REPORT, 1973-1974. (Nevada Univ., Reno (USA). Desert Research Inst.). 1974. 167p. Dep. NTIS $11.50.

Separate abstracts were prepared for two sections of this report. Both sections have been announced in ERDA Research Abstracts, and one has been announced in Nuclear Science Abstracts. (CH)

For an abstract of an individual section see: 2985.

2985 (TID-26872, pp 44-47) HYDROLOGY OF NEVADA TEST SITE AND DRIBBLE TEST SITE, MISSISSIPPI. Maxey, G. G.; Fenske, P. R. 1974.

In annual report, 1973-1974. (Nevada Univ., Reno (USA). Desert Research Inst.).

A computer-simulated water table map of the Nevada Test Site and environs was generated. Methods were developed for calculating the rate of infill of ground water in rubble chimneys formed by the detonation of an underground nuclear explosion. The optimum location for drilling test wells outside a rubble chimney to monitor the transport of radioactivity in ground water in the area was investigated. Radionuclide migration in ground water and salt water aquifers at the Dribble Site, Mississippi, was investigated. Radioactive wastes from the detonation of a nuclear explosive device at a depth of 2700 ft in a salt mine were deposited in a deep salt water zone at the Dribble Site. (CH)

2986 (TID-26884) OBSERVATIONS SUGGESTING MECHANISMS CONTROLLING LARGE-SCALE POLLUTANT DISPERSAL IN THE N. PACIFIC. Folsom, T. R. (Scripps Institution of Oceanography, La Jolla, Calif. (USA)). 1974. 35p. Dep. NTIS $4.75.

Some topics discussed are: historical record of global fallout as applied to the ocean; redistribution of fallout by the moving ocean; relation of fallout distribution to concentrations of certain fallout constituents measured in sea water and marine organisms during the past decade in the North Pacific; persistence of fallout near the sea surface; vertical profiles of concentration in the ocean; and development of models for fallout studies. (HLW)

2987 (UCRL-77318) EVALUATION OF THE USE OF SLUDGE CONTAINING PLUTONIUM AS A SOIL CONDITIONER FOR FOOD CROPS. Myers, D. S.; Silver, W. J.; Coles, D. G.; Lamson, K. C.; McIntyre, D. R.; Mendoza, B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 17 Sep 1975. 19p. (SM-199/42; CONF-751105-3). Dep. NTIS $4.50.

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, California, USA (17 Nov 1975).

An experiment was conducted to assess the potential hazard associated with the use of sludge containing plutonium as a soil conditioner for food crops. Conditions were chosen that would maximize exposure to the ^{239}Pu in the sludge through resuspension and in plant content and thus approximated the maximum potential hazards due to the inhalation and ingestion pathways. The estimated 50-year radiation doses to the pulmonary region of the lung, bone, and liver based on the results of the inhalation experiment are 6×10^{-4} rem, 1.2×10^{-3} rem, and 0.55×10^{-4} rem, respectively. Similarly, the 50-year radiation doses attributable to ingestion of the sludge-grown vegetables were 2.2×10^{-5} rem to the bone and 1.5×10^{-5} rem to the liver. Thus, the inhalation pathway is the more critical of the two. The maximum permissible annual doses to the lungs, bone, and the liver for a member of the general public are 1.5, 3.0, and 1.5 rem, respectively. Thus, the maximum credible 50-year lung, bone, and liver dose commitments associated with the use of the ^{239}Pu-contaminated sludge as a soil conditioner are approximately 4.0×10^{-2} percent of the annual maximum permissible dose. Under more realistic exposure circumstances, one might expect less drying of the sludge, less resuspension of dust and flying dirt before and during rototilling, and a much smaller sludge vegetable consumption rate. The conservative assumptions made in this analysis tend to assure that actual radiation doses would be even less than those calculated. (auth)

2988 UPTAKE AND MIGRATION OF TRACERS IN LAKE SEDIMENTS. Lerman, A.; Lietzke, T. A. (Northwestern Univ., Evanston, IL). Limnol. Oceanogr.; 20: No. 4, 497-510(Jul 1975).

Mathematical solutions are given for an equation describing transient and steady state concentrations in lake water and sediments, in the presence of adsorption, decay, sedimentation, and diffusion. The results of the model are compared with the distributions of two tracers, ^{90}Sr and ^{137}Cs, in the sediments of Lakes Erie and Ontario. Adsorption of the two tracers by sediment particles, supported by experimental data, can be treated

as a linear exchange reaction. ^{90}Sr is adsorbed less strongly than ^{137}Cs by sediments, and this feature accounts for the greater depths of ^{90}Sr occurrence in lake sediments. Distribution of the radionuclide activities in sediments is compatible with a model based on mean steady input to the lakes for 16 years (1953-1969), and the following values of diffusion coefficients in pore waters: for ^{90}Sr, 2×10^{-6} to 4×10^{-6} cm^2 S^{-1}, and for ^{137}Cs, 2×10^{-5} cm^2 S^{-1}. An additional transport mechanism in sediments, sedimentation, is more significant in Lake Erie (0.3-0.6 cm yr^{-1}, according to the model) than in Lake Ontario (0.05 cm yr^{-1}). Conditions are outlined under which the fluxes from lake water to sediments are important in the chemical balance of medium and large lakes. (auth)

Atmosphere

Refer also to abstracts 2634, 2976, 3021, 4635, and 4712.

2989 (INIS-mf-1236, pp 91-107) NUMERICAL METHOD OF THE SIZE-DISTRIBUTION CALCULATION FOR RADIOACTIVE PARTICLES FALLING ON TO THE EARTH SURFACE. Kownacka, L. (Centralne Lab. Ochrony Radiologicznej, Warsaw). 1972. (In Polish).

From Polish-German work group meeting; Warsaw, Poland (22 Jun 1970).

In radioactive pollution of environment. (Centralne Lab. Ochrony Radiologicznej, Warsaw (Poland)).

The paper deals with theoretical prediction of relative concentration of heavy particles falling on to the earth surface from a cloud caused by nuclear explosion. The calculation was based upon a simple linear model of radioactive cloud, whose size and maximum height in the atmosphere is the function of explosion yield. Particle size-distribution in the cloud is determined by the log-normal function, and their fall-rates were calculated by various methods depending on their respective size. The particle size-distribution on the ground as the function of the distance from the source was calculated by assuming the wind velocity is a linear function of the height. The six equations were obtained determining the relative concentration of the particle on the earth's surface. GIER computer was used for the numerical calculations, for the small explosions, producing clouds in the troposphere and for the distances covering the local fallout. Curves of the size-distribution of the particles for several distances and explosion yield are presented. Significant differences in the shape particle size-distribution for different explosion yields were found. (INIS)

2990 (JUL--1220) FUTURE RADIOACTIVE ENVIRONMENTAL POLLUTION IN THE FEDERAL REPUBLIC OF GERMANY BY RADIONUCLIDES FROM NUCLEAR POWER PLANTS IN NORMAL OPERATION. Bonka, H.; Bieselt, R.; Brenk, D.; Bruessermann, K.; Darvas, J.; Laser, M.; Schnez, H.; Schwarz, G.; Vogt, K. J.; Winske, P. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany)). Jul 1975. 237p. (In German). Dep. NTIS (US Sales Only) $9.00.

The future radiation exposure of human populations is estimated based on important gaseous and liquid radioactive effluents, mainly tritium, ^{85}Kr, ^{129}I, ^{131}I and ^{133}Xe, from modern nuclear power plants and corresponding reprocessing plants and a prediction of nuclear power plant expansion over a period of approximately 100 years. The local and regional radiation exposure due to gaseous wastes as well as the potential radiation exposure due to liquid effluents released into surface waters and their use for drinking water purposes are considered. The results are compared to the natural radiation exposure of the population in the Federal Republic of Germany. It was concluded that the future additional radiation dose will be within the limits of the fluctuation of the natural radiation exposure if it is possible to retain tritium and ^{85}Kr at a rate of about 90 percent to 99 percent and iodine at a rate of about 99 percent to 99.8 percent in the large reprocessing plants. (auth)

2991 (KFK--2153) PRODUCTION AND RELEASE OF ^{89}Sr, ^{90}Sr, ^{103}Ru, ^{106}Ru, ^{134}Cs, ^{135}Cs, ^{137}Cs, ^{141}Ce, AND ^{144}Ce BY NUCLEAR POWER PLANTS AND REPROCESSING PLANTS AND THE EXPECTED RADIOLOGICAL BURDEN UNTIL THE YEAR 2000. Schiesser, D. (Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Neutronenphysik und Reaktortechnik). Aug 1975. 172p. (In German). Dep. NTIS (US Sales Only) $7.75.

Thesis. Submitted to Karlsruhe Univ. (F. R. Germany). Fakultaet fuer Maschinenbau.

The environmental effects of the production of long-lived radioisotopes of the elements strontium, ruthenium, cesium, and cerium are summarized in this report together with the projected yields of ^{89}Sr, ^{90}Sr, ^{103}Ru, ^{106}Ru, ^{134}Cs, ^{135}Cs, ^{137}Cs, ^{141}Ce, and ^{144}Ce from nuclear power plants and other nuclear facilities. Specific production rates and the consequent release rates, representative of time are evaluated for the different types of nuclear power plants (1000 MWe). Estimated release rates from fuel reprocessing plants are also included, based on decontamination factors attainable at present. Local body burdens of human populations resulting from the releases of nuclides by nuclear power plants and reprocessing plants are estimated. Based on the forecasted development of nuclear facilities, the global accumulated activity released by these facilities until the year 2000 is calculated. (auth)

2992 (KFK-EXT-20/75-1) MONITORING FOR ENVIRONMENTAL RADIOACTIVITY AT THE KARLSRUHE NUCLEAR RESEARCH CENTER IN 1974. Winter, M.; Tachlinski, W. (Kernforschungszentrum Karlsruhe (F. R. Germany). Abt. Strahlenschutz und Sicherheit). Aug 1975. 54p. (In German).

Monitoring for environmental radioactivity at the Karlsruhe Nuclear Research Center is the responsibility of the Radiation Protection Department. A description is given of the routine environmental monitoring program as approved by the competent supervising authority of the state of Baden-Wuerttemberg. Results obtained in 1974 are presented. A survey of special monitoring steps and of results of background measurements performed for two nuclear power stations presently under construction are included. (CH)

2993 (ORP/CSD-75-1(Vol.2)) PROCEEDINGS OF PUBLIC HEARINGS: PLUTONIUM AND THE OTHER TRANSURANIUM ELEMENTS. Volume 2. Proceedings of Hearings in Denver, Colorado, January 10, 1975. (Environmental Protection Agency, Washington, D. C. (USA). Office of Radiation Programs). 1975. 550p. (CONF-750133-P2). Environmental Protection Agency, Washington, DC.

From proceedings of public hearings on plutonium and the other transuranium elements; Denver, Colorado, USA (10 Jan 1975).

Public hearings were held on the health hazards to human populations and environmental effects of Pu and other transuranium elements released to the environment. Public and technical concern has been expressed because of the long half-lives and high radiotoxicity of many nuclides of these elements. Information is included regarding the factors involved in balancing costs vs. benefits of Pu utilization for the production of fuels for nuclear power plants; other applications using Pu; dosimetry, health, environmental effects, and pathways for the uptake of Pu by man; and control and cleanup technology. (CH)

2994 (ORP/CSD-75-1(Vol.3)) PROCEEDINGS OF PUBLIC HEARINGS: PLUTONIUM AND THE OTHER TRANSURANIUM ELEMENTS. Volume 3. Additional Materials Received. (Environmental Protection Agency, Washington, D. C. (USA). Office of Radiation Programs). Oct 1974. 702p. (CONF-750133-P3). Environmental Protection Agency, Washington, DC.

From proceedings of public hearings on plutonium and the other transuranium elements; Denver, Colorado, USA (10 Jan 1975).

Data presented at public hearings regarding the health hazards to the human population from Pu released to the environment are presented. Data on the biological radiation effects of incorporated Pu in laboratory animals are reviewed and the possible hazards of lung carcinogenesis in man following the inhalation of PuO_2 particles are discussed. Comments from scientists and the public that reflect apprehension as to the hazards from Pu released to the environment are included. (CH)

2995 (RISO-M--1808) ESTIMATION OF POPULATION DOSES FROM A NUCLEAR POWER PLANT DURING NORMAL OPERATION. Nowicki, K. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jul 1975. 102p. Dep. NTIS (US Sales Only) $6.50.

A model is presented for estimation of the potential external and internal radiation doses to people located within a distance of 1000 km from a nuclear power plant during normal operation. The model was used to calculate these doses for people living 200 to 1000 km from a hypothetical nuclear power facility sited near the geographical center of Denmark. Two sources of radioactivity considered include the unit release of 15 isotopes of noble gases and iodines and liquid effluent releases from two types of 1000 MWe Light Water Power Reactors (PWR and BWR). Parameter variations were made and analyzed in order to obtain a better understanding of the mechanisms of the model. (auth)

2996 (UCRL-76936) IMPLICATIONS OF SAMPLING FROM A LOG-NORMAL POPULATION. Toy, A. J.; Lindeken, C. L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Sep 1975. 19p. (CONF-750967-13). Dep. NTIS $4.00.

From 3rd ERDA environmental protection conference; Chicago, Illinois, USA (23 Sep 1975).

The environmental radioactivity surrounding the Lawrence

Livermore Laboratory (LLL) is typically log-normally distributed. The geometric standard deviation of radioactivity in all types of samples (air, water, soil, sewage, and vegetation) is about two. Hypothesis testing was done using the mean geometric standard deviation of these samples. Parametric studies demonstrated the effect of the number of background samples, the magnitude of tolerable errors, the variability of the sample population, and the precision of the analysis on the detectability of differences from natural and global fallout radioactivity. It was decided to accept an error probability of 50 percent that the analysis would show a sample to be different from background when, in fact, it was not, and an error probability of 5 percent that the analysis would show a sample to be background, when in fact, it was not. For these assumptions, an analysis must differ from background by a factor of 1.6 to indicate a statistical difference, and a sample must contain radioactivity a factor of 8.6 different from background to be 95 percent detectable with 50 percent confidence. The difference in the mean of two such populations which is 95 percent detectable with 50 percent confidence is 2.8 if six samples are taken from each population. Applications in monitoring ^{239}Pu diffusion are described. (CH)

2997 NUCLEAR POWER PLANT RADIATION MONITORING SYSTEM. McArthur, W. C.; Kniazewycz, B. G. (Carolina Power and Light Co., Raleigh, NC). Health Phys.; 29: No. 3, 427-428 (Sep 1975).

A Radiation Monitoring System for nuclear power plants designed to reflect the philosophy and techniques necessary to meet the new stricter radiation limits is described. This system consists of digital or analog detectors whose signals are transmitted to an interface cabinet for appropriate processing and then fed via multiplexing to a computer for interpretation and historical data logging. The functions of the computer subsystem's hardware and software and the area radiation monitoring channels both liquid and airborne are discussed. (UK)

2998 RADIOACTIVITY IN THE AIR AND IN FOOD IN MOSCOW, 1971-1972. Zykova, A. S.; Telushkina, E. L.; Efremova, G. P.; Kuznetsova, G. A.; Kiselev, V. V. Gig. Sanit.; No. 3, 53-55(Mar 1975). (In Russian)

Measurements of radioactivity in fallout in Moscow and environs and in potatoes, milk, and cabbage are tabulated. The data show that the radioactive fallout and the atmospheric concentration just above the earth's surface were considerably lower in 1972 than in 1973. The ^{137}Cs content in the foods examined also decreased in the observation period. The total radioactivity in fallout and in atmospheric aerosols is broken down by fission product. (TTT)

2999 DISTRIBUTION OF ^{90}Sr IN MONTHLY PRECIPITATION SAMPLES FROM SOFIA, PLEVEN, AND VARNA, DURING THE PERIOD OF 1970-1971. Georgieva, L. Khidrol. Meteorol.; 22: No. 3, 25-36(1973). (In Russian)

The distribution of low activities of ^{90}Sr (Strontium-90) in the average monthly quantities, from the stations Sofia, Pleven, and Varna, during 1970 to 1971, was investigated. The methods of collecting the samples and the radio-chemical separation of ^{90}Sr is described. The establishment of ^{90}Y is made by measuring the activity of the daughter product ^{90}Y. The measuring equipment and the methods of detecting ^{90}Y is described. Sixty-four samples in all from a monthly precipitation are studied, 30 liters taken for each sample, and in the cases where the collected precipitation is less than the above liters, the whole quantity is processed. Diagrams are constructed of the specific and the deposited activity of ^{90}Sr precipitations, distributed by months for Sofia, Pleven, and Varna respectively. Clearly expressed spring and autumn maxima in the seasonal course were observed of the specific and the deposited β-radioactivity. The relationship between the specific and the deposited activity of precipitations of the above sea-level height is graphically expressed. The obtained results confirm the common stratospheric origin of the long-lived radionuclides in the surface air layer and speak of absence of fresh products for division. (Abstr. Bulg. Sci. Lit.)

3000 METEOROLOGICAL CONSIDERATION FOR NUCLEAR SAFETY. Sakagami, J. (Ochanomizu Univ., Tokyo (Japan). Faculty of Science). Genshiryoku Kogyo; 20: No. 9, 30-35(Sep 1974). (In Japanese)

Nuclear meteorology is reviewed by placing enphasis on diffusive concentration. Meteorological observation and the estimation of radiation exposure must be performed at least one year before the installation of an atomic power plant starts. Although theoretical calculation can be performed in case of simple topography, wind tunnel experiment is necessary in case of three dimensional topography and flow separation phenomenon because of difficult calculation. Horizontal diffusion is more affected by ground than vertical diffusion. Problem is in the region of only several tens meters above ground. The calculation of diffusive concentration was performed with Fick's differential equation. The quantities expressing the extension of cloud A and B in diffusion equations are different according to different atmospheric stability. The author has solved the Fick's equation, regarding as a diffusion coefficient Kz equals Kz. The author has also criticized Sutton's equation. The wind tunnel of the author's laboratory can produce any desired temperature distribution. The effect of temperature on strata forming is being experimentally studied. In case of particles such as ^{131}I, there is falling velocity. In case of the particles of 10μ diameter, the movement is almost the same as that of air. Future problem is that to what extent the diffusion equation can be applied. Most of atomic power plants locate at seaside. The concentration when the cloud that has moved from land to sea returns to the land by reversed wind is also a problem. Diffusion calculation in this case is under way not now. (JA)

3001 Pb-210, Bi-210 and Po-210 IN METEORIC PRECIPITATION AND THE RESIDENCE TIME OF TROPOSPHERIC AEROSOL. Tsunogai, S.; Fukuda, K. (Hokkaido Univ., Hakodate (Japan). Faculty of Fisheries). Geochem. J. (Nagoya); 8: No. 3, 141-152(Sep 1974).

The concentrations of ^{210}Pb, ^{210}Bi, and ^{210}Po in rain and snow were determined. Extremely high concentrations of ^{210}Pb, e.g. 190 dpm/l, were observed for snow produced from convective clouds by the north-west monsoon on 3 Feb. 1972, at Assabu, Hokkaido. The high concentration is due to the active convection in the continental air mass which contains much radon and has rather low absolute humidity. The $^{210}Bi/^{210}Pb$ ratio was higher in rain in summer than in snow in winter. By using the two models, CRM (continuous removal model) and SRM (sudden removal model), the residence times of aerosols in the atmosphere are calculated from the activity ratios, $^{210}Bi/^{210}Pb$ and $^{210}Po/^{210}Pb$. The residence time from the $^{210}Bi/^{210}Pb$ ratio is apt to be shorter for the snow by the winter monsoon. This is due to the addition of aged aerosols which may come from the lower stratosphere to the troposphere. By resolving the simultaneous equations, the percentage of aged aerosols and the true residence time of tropospheric aerosols are estimated to be 1 to 5% and 2 to 7 days for the snow produced by the winter monsoon. The residence time, however, varies widely owing to the origin and history of the air mass. (auth)

3002 INVESTIGATION ON THE MEASUREMENT OF ENVIRONMENTAL RADIOACTIVITY AROUND THE NUCLEAR POWER STATION. Takagi, S.; Nakaoka, A.; Kanbe, H. (Central Research Inst. of Electric Power Industry, Komae, Tokyo (Japan). Technical Lab. No. 1). Denryoku Chuo Kenkyusho Gijutsu Daiichi Kenkyusho Hokoku; No. 74029, 1-5, 1-20(Sep 1974). (In Japanese)

In order to solve a problem on the environmental radioactivity around a nuclear power station, it is the most fundamental that accurate and precise method of measurement must be developed on the determination of radioactivity in environmental samples. In this report, problems are pointed out concerning the measurement of environmental radioactivity at the present time. Distinctive features concerning the measurement of environmental radioactivity are as follows: 1) the extremely low level of radioactivity, and (2) the diversity of environmental samples and radionuclides to be measured. Problems on the measurement of environmental radioactivity are as follows: (1) no research on the representation of sampled specimens, (2) great error by unsuitable preservation and level preconcentration procedure, (3) great error by measurement of low radioactivity, (4) necessity of time and skillful analysts, (5) no establishment of standardized method of radioactivity measurement around nuclear power stations and the impossibility of evaluation of environmental radioactivity around nuclear power stations. To solve these problems written above, it is necessary to carry out research on; (1) the enhancement of systematic reliability of preconcentration and radiation measurement system, (2) improvement of measurement on rapidness and automation, and (3) standardization of radioactivity measurement around nuclear power stations. (auth)

3003 ORIGIN OF ^{90}Sr FALLOUT IN RECENT YEARS. Miyake, Y.; Katsuragi, Y. Tenki (Meteorol. Soc. Jap.); 21: No. 12, 47-52(Dec 1974). (In Japanese)

The ratio of the amount of ^{90}Sr fallout in the total fallout from newly exploded nuclear tests can be obtained from the ratio of ^{89}Sr with short half-life to ^{90}Sr and its change in the course of time. The calculation results of the amount of ^{90}Sr fallout from 1961 to 1972 are reported. The amount of ^{90}Sr fallout in Japan decreased from 1963 to 1967 with the half-life of about one year. It levelled off from 1967 to 1971, and decreased by 40% in 1972 as compared with the previous year. The ratio of ^{90}Sr fallout to the total fallout owing to the nuclear tests in the U. S. and the Soviet Union and the H-bomb test in China from 1961 to 1962 has been obtained from the measurement results of the $^{89}Sr/^{90}Sr$ ratio and the amount of ^{90}Sr fallout in Tokyo. (JA)

3004 RADON 222 FROM THE OCEAN SURFACE. Wilkening, M.H. (New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801); Clements, W.E. J. Geophys. Res. 80: No. 27, 3828-3830 (20 Sept 1975).

The flux of ^{222}Rn from the ocean surface has been measured by the accumulation method off the windward coast of the island of Hawaii. A figure of 74 ± 8 atoms m^{-2} s^{-1} was obtained, compared with a range of values from 11 to 116 atoms m^{-2} s^{-1} calculated from near-surface ^{222} Rn concentration profiles in seawater obtained by other investigators. If these results are representative, the total oceanic contribution to ^{222}Rn in the global atmosphere is only about 2% of all ^{222}Rn exhaled from continents. Fluxes obtained by the accumulation method in shallow bay waters nearshore were intermediate between the very low value measured in the open ocean and the values obtained onshore. (auth)

Soil

Refer also to abstract 3137.

Water

Refer also to abstract 2811.

3005 EVALUATION OF ENVIRONMENTAL POLLUTION TO BE CAUSED BY RADIOACTIVE WASTE RELEASES FROM THE FUEL REPROCESSING PLANT. Yamagata, N. (Institute of Public Health, Tokyo (Japan)). Koshu Eiseiin Kenkyu Hokoku; 23: No. 1, 17-49(Mar 1974). (In Japanese)

A comprehensive review has been attempted on the background studies and data available for the evaluation of radiation exposure to the inhabitants of Tokai District to be caused by radioactive waste releases to the environment from the Fuel Reprocessing Plant which is expected to be in operation in 1975. The main purpose of this review is to contribute to the establishment of a reasonable environmental monitoring system. (auth)

Ecosystems and Food Cycles

Refer also to abstract 3200.

3006 MARINE RADIOECOLOGY. Ancellin, J. (CEA Centre de La Hague, 50 - Cherbourg (France). Service de Recherches Toxicologiques et Ecologiques). pp 197-202 of 8th National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French).

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

The transfer of radioactive pollutants into the marine environment is reviewed as well as the socio-economic aspects arising from the problem of the disposal into the sea. (FR)

3007 EFFECTS OF PROCESSING TECHNIQUES ON THE RADIOACTIVE CONTAMINATION OF FOOD. Bovard, P.; Delmas, J.; Grauby, A. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Protection). pp 185-195 of 8th National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French).

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

Following contamination of cultures of rice, grapes, and various vegetables by ^{90}Sr and ^{137}Cs, the effect of processing and cooking techniques on the contamination of the food-stuff was investigated. (FR)

3008 POLLUTIONS ASSOCIATED TO RADIOACTIVE POLLUTIONS IN AQUATIC AND IRRIGATED ECOSYSTEMS. Bittel, R. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Protection). Radioprotection; 9: No. 2, 111-130(1974). (In French).

From meeting of the working group environmental pollution of the European Society for the use of nuclear methods in agriculture; Grenoble, France (23 Apr 1974).

Wastes from nuclear installations include radioactive pollutants and other types of pollutants. When dispersed into the environment, interactions occur between the radioactive pollutants and several other physical, chemical, or microbiological pollutants. The consequences of these associated pollutants on radionuclides transfer into aquifer and aquatic and irrigated trophic chains have been investigated by means of examples. They show the importance of the above concepts with a view to the best conditions of development of river basins or seashores. Thorough toxicological and metabolic investigations at the cellular and subcellular levels should contribute to the forecasting of long term consequences of associated pollutions of different types (radioactive or not radioactive) at very low levels, both for man and the environment. (FR)

Radiometric Techniques

Refer also to abstracts 3099–3101, and 3754.

3009 (LBL-4000, pp 358) CHRONOLOGY OF THE O. B. JAMES PLUTON. Drake, R. (Univ. of California, Berkeley); Bowman, H. R.; Hebert, A. J. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

3010 SPONTANEOUS FISSION–NEUTRON FISSION XENON: A NEW TECHNIQUE FOR DATING GEOLOGICAL EVENTS. Teitsma, A. (McMaster Univ., Hamilton, Ont.); Clarke, W. B.; Allegre, C. J. Science; 189: No. 4206, 878-880(12 Sep 1975).

A method for dating geological samples which uses fission product xenon in a manner similar to the use of radiogenic argon in the ^{40}Ar–^{39}Ar technique has been developed. The results of stepwise heating experiments for a zircon from the Ahaggar region in the Sahara are compared to the geochronology determined by the rubidium–strontium, uranium–thorium–lead, and potassium–argon dating methods. (auth)

3011 NAKAO PYROCLASTIC FLOW DEPOSITS OF MT. YAKEDAKE IN NORTHERN JAPAN ALPS AND THEIR ^{14}C DATING AGES. Fujii, S. (Toyama Univ. (Japan)); Sawada, T.; Takezawa, T. Dai-yonki Kenkyu; 13: No. 1, 1-8(Apr 1974). (In Japanese)

^{14}C data of some samples obtained from the Nakao pyroclastic flow deposits of Mt. Yakedake in the Northern Japan Alps are discussed. The samples consist of stumps, buried soil and pieces of wood or charcoal. Some samples obtained from the upper part of the deposits are dated older than those from the lower. It is considered that the samples which show inconsistency with stratigraphical observation have been derived from the older formation by the avalanche type of pyroclastic flow. In conclusion, the Nakao pyroclastic flow deposits are divided to three members stratigraphically, whose ages are determined after ^{14}C dating of stumps and buried soil in situ. (auth)

3012 OXYGEN ISOTOPE PALEOTEMPERATURE MEASUREMENTS ON PLEISTOCENE MOLLUSCAN FOSSILS FROM THE BOSO PENINSULA, CENTRAL JAPAN. Masuda, F.; Taira, K. (Tokyo Univ. of Education (Japan). Faculty of Science). Chishitsugaku Zasshi; 80: No. 3, 97-106(Mar 1974). (In Japanese)

The molluscan fossils from the Pleistocene Shimosa Group in the northern part of the Boso Peninsula, Central Japan have been analyzed to determine paleotemperature on the basis of their oxygen isotope ratio ($^{18}O/^{16}O$). The specimens used were the shells of Glycymeris yessoensis (SOWERBY), G. vestita (DUNKER), G. pilsbryi (YOKOYAMA), G. rotunda (DUNKER), and Mactra sulcataria (REEVE), because these fossil shells are well preserved and their material is chiefly aragonite. Among the $\delta^{18}O$ values of specimens from one and the same horizon, the maximum difference is 0.39‰, but the values are generally less than 0.25‰. The average oxygen isotope ratio of Glycymeris is 0.2–0.7‰ smaller than that of Mactra from the same horizon. In several cases, a slight difference in the oxygen isotope ratio is recognized between the inner layer and the outer layer. Paleotemperature of the depositional environment of the Shimosa Group is calculated as follows in descending order: Kioroshi Member, 10–15°C; Kamiiwahashi Member, 12–17°C; Kiyokawa Member, 10–15°C; Kamiizumi Formation, 9–15°C; Semata Formation, 9–19°C; and Jizodo Formation, 6.5–15°C. The lower part of the Semata Formation and the so-called "Jizodo Fossil Zone" do not indicate such a warm water temperature as judged from the faunal assemblages. In general, however, the paleotemperature obtained from the oxygen isotope analysis shows a good agreement with that from the faunal assemblages. (auth

3013 K-Ar AGE OF THE BIOTITES ACROSS THE CENTRAL PART OF HIROSHIMA GRANITES. Shibata, K.; Ishihara, S. (Geological Survey of Japan, Kawasaki, Kanagawa). Chishitsugaku Zasshi; 80: No. 9, 431-433(Sep 1974). (In Japanese)

Two different views have been published on the granites cropped out in San-yo and San-in districts, the one revealed that each had peculiar property, and the other said that both belonged to same activity. However, it has been generally considered that the granite in San-in district originated from the magma generated later in

different places from that in San-yo district, and solidified in different environment. The data on isotope age have been used to emphasize the younger age of the granite in San-in district. The age and the change of rock system at the junction point between both districts are unsolved. Therefore sampling was carried out at the boundary between Hiroshima and Shimane prefectures, and the measurement of K-Ar age was made by the authors. According to preliminary study, main part was biotite adamellite of medium to coarse grains. The K-Ar age of the biotite in Hiroshima granite showed remarkable difference on the north side and south side of Ō asa in north Hiroshima, 38 to 64 million years in case of the former, and 80 to 82 million years in the latter case. The age changed in extremely short distance of about 2 km. The younger rocks around the place where the K-Ar age changed were fine grains, and had spotted or patterned structure, and are different from older rocks. The oldest age obtained in Shimane was 64 million years in coarsest rocks. It is expected that a line of discontinuity runs in the vicinity of Ō asa from east to west. Future re-examination is necessary. (JA)

3014 ^{14}C-AGE OF PEATS IN TANEMORI, AKITA PREFECTURE. ^{14}C-Age of the Quaternary Deposits in Japan, (101). Shoji, S.; Ando, Y.; Masui, J. (Tohoku Univ., Sendai (Japan). Faculty of Agriculture). Chikyu Kagaku; 28: No. 5, 197(Sep 1974). (In Japanese)

^{14}C-age determination of peats in Tanemori, Akita Prefecture was performed in order to presume the successive accumulation of humic volcanic ash soils in the environs of Jumonji-machi, Hiraga-gun. Beneath the surface layer in the locality which has been artifically disturbed, at least four volcanic ash layers were found, making alternate layers with peat beds. Of these peat beds, the first and the third (3-5 cm and 34-39 cm from the surface, respectively) were selected for the ^{14}C-age determination, which was done by Prof. K. Kogoshi, using humic acid extracted from them. The ^{14}C-age values obtained were considerably old, being 4,600 ± 110 y.B.P. and 12,880 ± 210 y.B.P. respectively. (JA)

3015 ^{14}C-AGE OF THE PEAT IN THE ZAO LACUSTRINE DEPOSITS OF TOKATTA HOT SPRING SITE, MIYAGI PREFECTURE. ^{14}C-Age of the Quaternary Deposits in Japan (103). Imaizumi, R. (Tohoku Univ., Sendai (Japan). Coll. of General Education). Chikyu Kagaku; 28: No. 5, 199-201(Sep 1974). (In Japanese)

Along the upper course of the Matsu-kawa in the vicinity of Tōkatta, Zaō-machi, a low terrace develops, which is probably contemporaneous in its formation with the Tachikawa Terrace in southern Kantō. Many borings for hot springs in this area have shown the existence of the Quaternary Zaō lacustrine deposits composed mainly of gravel beds occasionally intercalating laminated materials. The so-called peat taken up from the depth of 70 m in a boring is one of these materials, and it consists of coaly, clayey, fine sands. Its ^{14}C-age determination was done by Prof. K. Kigoshi at the request of the author, and a value of 34,400 ± 1,000 y.B.P. was obtained. (JA)

3016 IN SITU SOIL GAMMA ANALYZER: A NEW APPROACH TO DETERMINE THE MOVEMENT OF POLLUTANTS IN SOILS. McFarlane, J. C.; Brown, K. W.; Kinnison, R. R. (National Environmental Research Center, Las Vegas, NV). Soil Sci.; 120: No. 2, 140-146(Aug 1975).

The in situ soil gamma analyzer is an instrument constructed to measure the position of gamma-emitting trace elements in soil. It consists of a solid state scintillator, a lead shield with a 3-mm-wide horizontal window, and a portable analyzer. When the detector is lowered into a circular excavation dug vertically into the soil of interest, the gamma activity of the tracer is plotted as a function of depth thus yielding a profile of the tracer distribution. Because of a broad base profile in the original plotted data, which is due to soil attenuation and the lack of collimation, a computer program was written to replot the distribution pattern to within +-1 mm of actual position. By making a series of time-related measurements, the rate of pollutant movement in soil is obtained. (auth)

Site Surveys

Refer also to abstracts 2982, 2992, 2996, 3021, and 3022.

3017 (HEDL-TME-75-38) FISH PROTECTIVE DEVICES: A COMPILATION OF RECENT DESIGNS, CONCEPTS, AND OPERATING EXPERIENCE OF WATER INTAKES USED IN THE UNITED STATES. Sonnichsen, J. C. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Jul 1975. Contract AT(45-1)-2170. 86p. AT.

The report reviews concept designs and fish protective screens and devices used in the United States to protect fish. Primary emphasis is placed upon reviewing actual and proposed designs used at thermal power plants to avoid impingement and/or entrapment of fish. The design and operation of fish protection devices used in and around hydro-electric power plants and water diversion projects is also briefly discussed. To add breadth to the subject matter, an appendix has been included which contains three bibliographies compiled separately by researchers in the United States. In each case, permission to include this material was obtained from the principle author. (auth)

Thermal Effluents

Refer also to abstract 4832.

3018 EFFECT OF HOT DRAINAGE ON FISHERY. Tanii, K. (Japanese Fishery Resources Conservation Association, Tokyo). Genshiryoku Kogyo; 20: No. 7, 23-27(Jul 1974). In Japanese)

Seeing the contribution of deepsea fishery to the supply of animal protein in Japan, the world-wide tendency to restrict foreign fishing boats from each territorial water compells one to take a serious view of not only coastwide fishery, but also fish farming along coast. The effect of hot drainage from nuclear power generation plants on the coastwide fishery is reported and discussed. The power generation by atomic energy in Japan is about two million KW at present, which is estimated to be increased to 60 million KW in 1980. The effect of hot drainage from the power generation plants in the USA and in Japan are reported as examples. The change of biota by the Turkey Point power plant is reported, in which the increment of water temperature does not always affect ecological system in subtropical area, if the water temperature and drainage volume are properly controlled. In the Long Island Straits on the east coast, there are at least 18 power plants running to supply for the population in and around New York. The amount of drainage from these plants is estimated to be 130 to 170 tons per second, which is supposed to impose stress on various kinds of marine life, especially in the period of high water temperature in summer. In spite of the effect of power plants on biota described above, New Sendai steam power plant and Tsuruga nuclear power plant do not cause such serious problems in fishery damage so far. The factors in the difference are investigated from the viewpoints of topography and the control of drainage. (Yamamoto, Y.)

3019 EFFECT OF HOT DRAINAGE ON MARINE LIVES IN THE WAKASA STRAITS. Niwa, S. (Fukui Prefectural Fisheries Experimental Station, Tsuruga (Japan)). Genshiryoku Kogyo; 20: No. 7, 28-32, 70(Jul 1974). (In Japanese)

The effect of the hot drainage from the Tsuruga power plant of Japan Atomic Power Co. Ltd. and the Mihama power plant of Kansai Electric Power Co. Ltd. on marine lives were studied. The effect of hot drainage on the temperature of sea water differs to a large extent according to the condition of location of plants. The diffusion of hot drainage is rapid, if the inflow of sea water from lower layer is easy, or the sea is open in which diffusion coefficient is large. The diffusion of hot drainage can not be discussed only from the amount of drainage. Clear difference was observed in plankton amount and its dominant species between inside and outside of bay before the operation of the plant, but the difference was not observed after the operation. On the other hand, no evident change in the amount and the dominant species was observed at the drainage side. The effects on shallow water livings are observed in detail. The observation of the effect on fishery shows no clear change in the dominance of fish species. However, the species of weak resistance to temperature change should be investigated. (Yamamoto, Y.)

Chemical Effluents

3020 (CONF-740370-) PROCEEDINGS OF THE FOURTH ANNUAL INDUSTRIAL AIR POLLUTION CONTROL CONFERENCE, KNOXVILLE, TENNESSEE, MARCH 28-29, 1974. State of the Art of Air Pollution Control Techniques for Industrial Processes and Power Generation. Noll, K. E.; Davis, W. T.; Walling, J. O. (eds.). (Tennessee Univ., Knoxville (USA). Dept. of Civil Engineering). 1974. 563p. Univ. of Tennessee, Knoxville $10.00.

Information was presented on air pollution problems associated with a wide range of industries. One item was included in Nuclear Science Abstracts and one item was abstracted for ERDA Research Abstracts. (SFL)

For an abstract of an individual paper see: 4635.

3021 (CONF-750967-11) ENVIRONMENTAL ANALYSIS OF THE OPERATION OF THE ERDA FACILITIES IN OAK RIDGE. McWherter, J. R. (Oak Ridge National Lab., Tenn. (USA)). 1975. 7p. Dep. NTIS $4.00.

From 3rd ERDA environmental protection conference; Chicago, Illinois, USA (23 Sep 1975).

An analysis of the environmental effects of current ERDA operations in Oak Ridge is being conducted to establish a baseline for the consideration of the environmental effects of additional facilities or modified operations in the future. An extensive ecological survey has been conducted for about one year; social and economic data were obtained; and an archaeological survey of the area was made. The facilities were described and the effluents associated with operations were quantified to the extent practical. The effects of effluent releases to the environment are being analyzed. The social effects of the ERDA facilities in Oak Ridge are also being studied. (auth)

3022 (SRO-825-1) REPORT ON THE METHYLMERCURY SITUATION IN PAR POND. Final Report. Schindler, J. E.; Williams, D. J.; Alberts, J. J. (Georgia Univ., Athens (USA). Dept. of Zoology). Jun 1975. Contract AT(38-1)-825. 22p. Dep. NTIS $4.50.

Studies are reported on the methylation and accumulation of mercury in fish populations of the pond. Results showed that the majority of the mercury in the fish muscles was in the methyl mercury form. Very low concentrations of mercury were found in the pond sediments. Physiological methylation of the mercury could not be demonstrated by in vivo or in vitro techniques. Organic ligand methylation and reduction of the mercury was shown to be a possible mechanism to account for both the mercury distribution in the pond and the concentrations of methylmercury in the fish. Recommendations are made for remedial treatments to eliminate the mercury problem. (HLW)

3023 CLOSED ENVIRONMENT PROBLEMS IN NUCLEAR SUBMARINES. Davies, D. M. (Inst. of Naval Medicine, Gosport, Eng.). Ann. Occup. Hyg.; 17: No. 3-4, 239-244(Feb 1975).

The introduction of the nuclear reactor into submarines promised unlimited underwater endurance. This could only be achieved if the human problems of continuous exposure to the sealed atmosphere of the totally closed environment could be overcome. Foremost amongst the problems was the establishment of permissible levels for continuous exposure to toxic substances in the atmosphere. The problems are discussed, as are the methods currently used in the Royal Navy to deal with them. Evidence so far available indicates that adequate control of the closed environment has been achieved. (auth)

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 3016, 3285, and 4288.

3024 (BNL-20366) TRIPLE-COINCIDENCE WITH AUTOMATIC CHANCE COINCIDENCE CORRECTION. Chase, R. L. (Brookhaven National Lab., Upton, N. Y. (USA)). May 1975. 12p. (CONF-751116-2). Dep. NTIS $4.00.

From nuclear science symposium; San Francisco, California, USA (19 Nov 1975).

The chance coincidences in a triple-coincidence circuit are of two types–partially correlated and entirely uncorrelated. Their relative importance depends on source strength and source and detector geometry so that the total chance correction cannot, in general, be calculated. The system described makes use of several delays and straightforward integrated circuit logic to provide independent evaluation of the two components of the chance coincidence rate. (auth)

3025 (CONF-750482-2) REMOTE ACQUISITION OF GAMMA-RAY PULSE HEIGHT SPECTRA. Killian, E. W.; Heath, R. L. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). 1975. 4p. Dep. NTIS $4.00.

From DECUS symposium; Miami, Florida, USA (15 Apr 1975).

The acquisition of pulse height spectra data in the industrial environment has traditionally evolved along two paths. The first required the transporting of a radioactive sample from the place of production to a computer system for counting and analysis. This method results in a degradation of the data due to the time delay between sample production and subsequent counting. The second path was taken to count the sample at the place of production and transport the data in the form of paper or magnetic tape to a computer for analysis. Automation of the traditional methods is usually impractical. This paper describes two methods of remote data acquisition developed at the Idaho National Engineering Laboratory which were formulated to mechanize the complete process from data gathering to analysis. Both methods utilize voice grade telephone links between the data gathering device and a PDP-9 computer. The two methods differ in the type of device used to acquire the data. The first is a completely hardwired system. The second is a computer based system utilizing a PDP-8/E. Differences between the two systems are described and evaluations made as to cost versus versatility. (auth)

3026 (CRN/PN-75-1) PROPERTIES OF VAPOR PHASE GROWN MERCURIC IODIDE SINGLE CRYSTALS. Ponpon, J. P.; Stuck, R.; Siffert, P.; Meyer, B.; Schwab, C. (Centre National de la Recherche Scientifique, 67–Strasbourg (France). Centre de Recherches Nucleaires). 1974. 20p. (CONF-741255–1). Dep. NTIS (US Sales Only) $4.25.

From nuclear Science Symposium; Washington, District of Columbia, USA (Dec 1974).

The growth of red mercuric iodide single crystals by a dynamic sublimation method is described. Their characterization has been performed by means of optical and electrical measurements. Nuclear radiation detectors have been prepared with this material and their properties are evaluated in terms of α particles, γ- and X-rays spectrometry, detection efficiency, electron-hole pair creation energy and polarization effects. Finally the potential use of mercuric iodide in nuclear detection is discussed. (auth)

3027 (CRN/PN-75-2) PREPARATION AND CHARACTERIZATION OF DIAMOND DETECTORS. Kozlov, S. R.; Stuck, R.; Hage-Ali, M.; Siffert, P. (Centre National de la Recherche Scientifique, 67–Strasbourg (France). Centre de Recherches Nucleaires). 1974. 21p. (CONF-741255–3). Dep. NTIS (US Sales Only) $4.50.

From Nuclear Science Symposium; Washington, District of Columbia, USA (Dec 1974).

It is shown that natural diamond can be used as a homogeneous conduction counter with near complete charge collection, even over a long period of time. Indeed, polarization effects have been suppressed by making the back contact of the detector injecting under the influence of the applied field in order to compensate for trapped charge carriers. The electric and detection characteristics of these counters have been investigated. Possible application fields are briefly discussed. (auth)

3028 (CRN/PN-75-3) CADMIUM TELLURIDE NUCLEAR RADIATION DETECTORS. Siffert, P.; Cornet, A.; Stuck, R.; Triboulet, R.; Marfaing, Y. (Centre National de la Recherche Scientifique, 67–Strasbourg (France). Centre de Recherches Nucleaires). 1974. 41p. (CONF-741255–2). Dep. NTIS (US Sales Only) $5.00.

From Nuclear Science Symposium; Washington, District of Columbia, USA (Dec 1974).

The characteristics and performance of undoped high resistivity cadmium telluride detectors are compared to chlorine compensated counters. It is shown, in particular, that "undoped" CdTe is in fact aluminium doped and that compensation occurs, as in silicon or germanium, by pair and triplet formation between the group III donor and the doubly charged cadmium vacancy (V_{Cd}^{2-}) acceptor. Furthermore, in chlorine doped samples, the polarization effect results from the unpaired (V_{Cd}^{-}) level at $E_c - 0.6$ eV. (auth)

3029 (EGG-1183-2319) NUCLEAR RADIATION MEASUREMENT USING CERENKOV LIGHT GENERATED IN A LIGHT GUIDE. Doyle, J. E.; Nelson, M. A.; Davies, T. J.; Franks, L. A. (EG and G, Inc., Goleta, Calif. (USA)). Jun 1975. 9p. (CONF-751101-27). Dep. NTIS $4.00.

From joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

Measurement of the Cherenkov response of a low-loss fiber optic light guide has established the feasibility of a simple nuclear diagnostic measurement technique wherein a small section of the guide is irradiated by charged particles to generate a radiation-proportional optical signal. The measurements described appear to show useful sensitivity, wide bandwidth, and other advantages associated with use of a light guide simultaneously as a radiation converter and optical signal transmission link. Typical observed sensitivity is 5.5×10^3 photons per nanosecond at 570 nm for an incident relativistic electron flux of 4 A per cm^2 in a 50-ps pulse. Time resolution for a 500-m multimode graded index fiber was 1.6 ns using a 5-nm-wide optical filter. (auth)

3030 (EUR–5273d-e-f(Vol.1), pp 375-387) SOME QUALITATIVE CONSIDERATIONS AFFECTING THE VARIATION OF W-VALUES. Dennis, J. A. Mar 1975.

From 2nd symposium on neutron dosimetry in biology and medicine; Neuherberg/Munich, F. R. Germany (30 Sep 1974).

In proceedings of second symposium on neutron dosimetry in biology and medicine. I.

A historical review on theoretical and experimental studies on the variation of W-values for various ions, targets, and energies is presented. (WHK)

3031 (INIS-mf-1698, pp 293-299) EFFICIENCY OF THE STILBENE CRYSTAL FOR NEUTRONS WITH 1 TO 20 MeV ENERGY. Kuz'min, E. A.; Sidorov, N. I.; Chulkov, L. V.; Yan'kov, G. B. 1974. (In Russian)

From 2nd all-union conference on neutron physics; Obninsk, USSR (3 Mar 1974).

In neutron physics. Part 4. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.).

This study presents the results of Monte Carlo calculations on the line form and efficiency of a stilbene neutron detector for neutron energies of 1 to 20 MeV. The anisotropy in light output of the recoil protons is taken into account in the calculations. It is shown that the contribution to the efficiency from alpha particles of the C-12(n,α)Be-9 and the C-12(n,n'2α)He-4 reactions is significant at neutron energies above 12 MeV. (tr-SJR)

3032 (ORNL-tr-4035) MEASUREMENT OF MULTIPLICITY OF FISSION NEUTRONS USING A LARGE-VOLUME SCINTILLATOR CONTAINING GADOLINIUM. Ribrag, M.; Poitou, J.; Matuszek, J.; Signarbieux, C. Translated by M. Gerrard from Rev. Phys. Appl.; 7: No. 3, 197-203(1972). 14p. Dep. NTIS $4.50.

A large liquid scintillator filled with gadolinium and used at Saclay for fission neutron-multiplicity experiments is described. An original procedure for optimal adjustments of the detecting system and its associated electronics so as to minimize possible systematic errors is also presented. Several errors and their associated corrections are treated in detail. Results for spontaneous fission of ^{252}Cf are compared with the data published by others. (auth)

3033 (RCN-231) NEUTRON SELFSHIELDING OF ACTIVATION DETECTORS USED IN SPECTRUM UNFOLDING. Zijp, W. L.; Nolthenius, H. J. (Stichting Reactor Centrum Nederland, Petten). Aug 1975. 27p. Dep. NTIS (US Sales Only) $5.00.

Neutron selfshielding corrections for activation detectors have been studied with a computer program SELFS, which is used in combination with SAND-II, the computer program for determining neutron spectra with aid of a set of irradiated foil detectors. The method does not apply integral correction factors to the measured activities, but applies energy dependent correction factors to the group cross section values. This calculation method has the advantage that correction can be calculated only once for a given foil thickness, and can be applied to each neutron spectrum with known shape. The applied formula to calculate the selfshielding is valid under limited conditions, but in practice the elementary formula provides data which are accurate enough. The results of calculations have been compared with literature data (e.g. for 1/E neutron spectrum, and for the neutron spectra of the ΣΣ facility in Mol and CFRMF in Los Alamos). The cross section data required were taken from the SAND-II, ENDF/B and the BNL-325 data sources. The program SELFS is written in FORTRAN and was used on a CDC-6600 computer. (auth)

3034 LIGHT AND SOUND WARNING DEVICE COMBINED WITH RADIATION LEVEL DETERMINATION SENSORS. Preisser, J.; Breton, B. pp 479-483 of 8. National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French).

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

Among the health physics equipment available on the market and if one considers the number of thresholds and the coding of light and sound indications, there are no compact, independent units complying with the specifications in use in the C. E. A. An alarm block representing the light and sound part of such a device is described. The alarm block operates from analog or logical quantities. The appearance and disappearance of alarms follow a certain coding. The study is divided into two parts relating to analog and logical systems. (FR)

3035 A DEVICE AND METHOD FOR LOCATING A LUMINOUS IMPACT ON THE PHOTOCATHODE OF A PHOTOMULTIPLIER. Odru, R.; Vacher, J. (to CEA, 75 - Paris (France)). French Patent 2,214,963/A/. 23 Jan 1973. 11p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

The device comprises a photomultiplier of known type, two insulated crossed network of parallel conductors in the vicinity of the photomultiplier photocathode, means for applying an electric pulse on said conductors in succession, means for defocussing the photo-electron beam emitted by the photocathode, means for dividing the signal as collected at the photomultiplier-anode into two identical signals S and S_2, means for delaying signal S_2 and adding thereto a constant shift voltage, means for sensing the moments when signals S and S_2 are equal. This can be applied to the manufacture of gamma cameras. (FR)

3036 DETERMINATION OF THE STATIC AND DYNAMIC CHARACTERISTICS OF SOME ATMOSPHERIC RADIO-CONTAMINATION MONITORS BY α SPECTROMETRY. Lasseur, C.; Troesch, G.; Andreucci, P.; Gaudiau, J.; Lelievre, B. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Service de Protection contre les Rayonnements). pp 391-409 of 8. National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French).

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

A comparative study was carried out on the main characteristics of three types of atmospheric plutonium contamination monitors. Two foreign portable monitors, Radeco model IC330 and Eberline Alpha-Air monitor model Alpha I, and a French portable monitor, Merlin-Guerin type DFF Pu 11, were studied. The static yield, physical resolution, dynamic yield and sensitivity of each were tested and it was found that an apparatus with a high dynamic detection yield constant as a function of energy does not necessarily have a better detection threshold. This factor depends only on the sampling method and the means of detection used. For the kind of instruments tested the physical resolution is the only important characteristic and alone governs the specificity and detection threshold. (FR)

3037 THE SPARK CHAMBER, DETECTOR OF LOW-ENERGY X OR γ RADIATION IMAGES. Morucci, J. P.; Girardey, A.; Moretti, J. L. (Paris-12 Univ., 94 - Creteil (France)). pp 411-421 of 8. National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French).

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

The qualities and defects of a low-energy X or γ radiation image detector are summed up and the problems involved in its application are discussed. Although the use of the spark chamber is limited where man is concerned it seems that experiments on small animals may offer interesting prospects. The results obtained on animals with various radioelements such as ^{125}I, ^{169}Yb and ^{99m}Tc are shown. (FR)

3038 FREQUENCY ANALYSIS AND SCINTIGRAPHY PROCESSING. 2. Non Enhancement Linear Stationary Filters. Berche, C.; Di Paola, R. (Institut National de la Sante et de la Recherche Medicale (INSERM), 75 - Paris (France)). J. Biol. Med. Nucl.; 9: No. 37, 16-39(1974). (In French).

A theoretical study of the frequency analysis applied to scintigraphy systems is presented. The fundamental frequency characteristics of digital linear stationary filters used in scintigraphy processing are described, and the main digital linear nonstationary and nonlinear filters used in the same domain are exposed. (FR)

3039 METEOROLOGY OF VERY WEAK ACTIVITIES. Hilaire, Michel (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Lab. de Metrologie des Rayonnements Ionisants). pp 423-437 of 8. National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French).

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

In the determination of low level activities, the necessary techniques do not differ fundamentally from those used for higher activities but they require the devising of appropriate measurement and calibration systems. They mandatorily require detectors with the smallest possible inherent movement. The laboratory, of which the fundamental characteristics are given, is therefore so designed, to wit, to enable the three causes of inherent movement to be reduced: cosmic radiation, contamination of materials and the ambient radiation of the laboratory. A description is also given of a number of measuring systems: alpha determination apparatus, beta determination apparatus and Ge-Li gamma spectrometry apparatus. (FR)

3040 USE OF DIGITAL TECHNIQUES FOR CENTRALIZED RADIATION MONITORING. Castri, J. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Protection contre les Rayonnements). pp 439-452 of 8. National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French).

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

Attention is drawn to the advantages of continuous centralized radiation monitoring in health physics, whether under normal running conditions or when accidents occur. In view of the technological progress which has led to the development of reliable instruments and inexpensive computers it is now possible to contemplate a centralised radiation monitoring system using digital techniques systematically (data transmission and processing). The general idea for such a system is presented and has been adopted for a future 18-line RCP (Radiation Control Panel) at the solid waste treatment building of the CEN Saclay. The specifications and the expected efficiency of the detectors chosen are given, data from the transducers are analyzed and the different functions of the RCP to which these data are transmitted are described. (FR)

3041 GENERAL SATURATION CURVE FOR AN IONIZATION CHAMBER FILLED WITH NITROGEN AT PRESSURES UP TO 8 ATMOSPHERES. Boag, J. W.; Seelentag, W. W. (Inst. of Cancer Research, Sutton, Eng.). Phys. Med. Biol.; 20: No. 4, 624-626(Jul 1975).

A plane parallel ionization chamber was used for measuring the saturation curve in nitrogen at pressures of up to 8 atmospheres. General recombination, dependent on the dose rate, is important under these conditions, whereas the effects of initial recombination are comparatively small. The ionization chamber was designed to permit high collecting fields to be applied to the layer of ionized gas without introducing local field concentrations.

Irradiation was from a 2000 Ci ^{60}Co source, and the electrode spacing could be varied between 3 and 13 mm. An empirical formula has been derived, which was shown to fit the experimental results over a pressure range of 1 to 8 atm, electrode spacings of 5 to 13 mm and applied voltage of 5V to 25 kV. The application of the resulting saturation curve to ionization chambers with cylindrical or spherical geometry is briefly discussed. (UK)

3042 ANTIMONY, ARSENIC, BROMINE AND MERCURY IN ENAMEL FROM HUMAN TEETH. Rasmussen, E. G. (Rigshospitalet, Copenhagen (Denmark)). Scand. J. Dent. Res.; 82: 562-565(1974).

The concentrations of antimony, arsenic, bromine, and mercury have been determined in enamel from ancient and contemporary human teeth. Fifty-two enamel samples were analyzed: 10 from 2300 to 1500 B. C., 8 from 400 B. C.–200 A. D., 3 from 800 to 1100 A. D., 14 from 1100 to 1400 A. D., 5 from the 1850's, and 12 from the present time. All teeth were taken from dated skulls or young patients with no fillings. The samples weighed between 30 mg and 60 mg. The concentrations of the four elements were determined after neutron activation and radiochemical separation by means of a NaI(Tl) scintillation well detector and a T. M. C. 400-channel analyzer. The ranges of concentrations were antimony: < 0.001 to 1.59 μg per g enamel; arsenic: < 0.001 to 0.406 μg per g; bromine: 0.87 to 7.3 μg per g; mercury: < 0.001 to 1.88 μg per g enamel. It was not possible to group the samples according to differences in concentrations of each of the four elements. (auth)

3043 NEUTRON DETECTION AND RADIOGRAPHY. Bollen, R. H.; Van Esch, R. F. (to Agfa-Gevaert, N. V.). US Patent 3,891,852. 24 Jun 1975. Filed date 3 Nov 1972. 24p.

An improved method of recording neutron images is described which comprises imagewise irradiating with neutrons an intensifying screen containing a gadolinium compound that fluoresces when struck by x-rays and subjecting the fluorescent light pattern resulting from the impact of the neutrons on the screen onto a photographic material. (auth)

3044 APPARATUS FOR RADIOLOGICAL EXAMINATION OF A SUBJECT THROUGH A SOLID ANGLE. Grady, J. K.; Rice, D. B. US Patent 3,892,967. 1 Jul 1975. Filed date 10 Dec 1973. 6p.

A framework supporting a radiation source, such as an x-ray tube, and a radiation receptor, such as an x-ray film plate holder, comprises four arms pivotally connected to form a regular parallelogram, a parallel pair of the arms extending outside the parallelogram to pivot points for the radiation source and receptor. The parallelogram is mounted on a rotor whose central axis is parallel to the parallel pair of arms. Two links between another one of the arms and the source and receptor respectively, and parallel to the central axis, hold the axis of the source and receptor aligned on a radiation axis which passes through an isocenter on the central axis as the parallelogram is angularly adjusted in planes parallel to the central axis. The angular adjustment of the parallelogram combined with turning of the parallelogram on the rotor permit the source to radiate through a subject at the isocenter, for example the human heart or brain, from throughout a solid angle while maintaining constant radiological distance between the source and subject and a constant axial alignment of the source and receptor. The radiological magnification may also be kept constant, or the receptor may be adjusted along its axis, in which case a counterweight reciprocating along the transverse arm and connected to the receptor by two cables counterbalances the receptor in all solid angle positions. (auth)

3045 RADIATION SENSITIVE SOLID STATE DEVICES. Shannon, J. M.; Ralph, J. E. (to U. S. Philips Corp.). US Patent 3,887,936. 3 Jun 1975. Priority date 22 Sep 1972, United Kingdom of Great Britain and Northern Ireland. 20p.

A solid state radiation sensitive device is described employing JFETs as the sensitive elements. Two terminal construction is achieved by using a common conductor to capacitively couple to the JFET gate and to one of the source and drain connections. (auth)

3046 ENERGY TRANSPORT BY GAMMA-RAY EXCITATION IN FLUORESCENT LIQUID SOLUTIONS. Kawski, A.; Wasniewski, T. (Univ., Danzig). Acta Univ. Szeged., Acta Phys. Chem.; 20: No. 3, 315-320(1974).

Experimental results on the radioluminescence efficiency η_s of a number of scintillators (solutes) in two different solvents under gamma excitation are presented. These results are compared with the Kallmann–Furst theory and the three Kallmann parameters P, Q, R are determined. Linear dependence of η_s on the ratio of P/R is found for different solutes in a given solvent. The physical significance of the Kallmann parameters is studied. (auth)

3047 WALL EFFECT OF IONIZATION CHAMBERS IN MEASUREMENT OF IONIZATION CURRENT DUE TO SEVERAL GASEOUS α-RADIOACTIVE SOURCES. Monte Carlo Calculation. Tachino, T.; Ikebe, Y.; Shimo, M. (Nagoya Univ. (Japan). Faculty of Engineering). Nippon Genshiryoku Gakkaishi; 16: No. 12, 626-631(Dec 1974). (In Japanese)

In measuring the ionization current due to gaseous α-radioactive sources with an ionization chamber, we must make a correction to compensate the reduction of current due to the wall effect, which is absent when the current is measured with a wall-less ionization chamber. In this report, we calculate the wall effect by a Monte Carlo calculation on two types of ionization chambers - the parallel plate chamber (electrode distance: 0.5 ~ 30 cm) and the cylindrical chamber (radius: 4, 6, 8, 12 cm, length: 10 ~ 80 cm) - and for several gaseous α-radioactive sources - Rn, Tn, ThA, etc., 4.196 ~ 8.785 MeV. The results obtained are presented graphically, and they agree approximately with experiment and with the Monte Carlo calculation undertaken by other workers. (auth)

3048 NEUTRON COUNTING STATISTICS IN THE FAMILY-FIRST-PULSE-TRIGGERED GATE, (I). The First Moment. Furuhashi, A. (Tokyo Univ. (Japan). Nuclear Engineering Research Lab.). J. Nucl. Sci. Technol. (Tokyo); 12: No. 3, 145-153(Mar 1975).

The first moment of neutron counts registered in the family-first-pulse-triggered gate—i.e. the object of observation in the usual Rossi-α experiment—is analyzed as a function of waiting time from the instant of family-birth to that of the trigger. The correlation amplitude is shown to increase with the waiting time, yielding when averaged over the waiting time distribution the currently used expression of this amplitude. The structure of the uncorrelated count-rate is made clear, and is shown to consist of two kinds of time-dependent parts, which are formulated as functions of time after the trigger. (auth)

3049 SYSTEMS OF SCINTI-SCANNING. Ueyanagi, H. (Shimadzu Seisakusho Ltd., Kyoto (Japan)). Genshiryoku Kogyo; 20: No. 10, 21-24(Oct 1974). (In Japanese)

Scinti-scanning is a recently pervaded method to detect and record from the outside the morphological and time-varying accumulation of radioisotope labelled compounds, which have been administered to patients, in the organs being tested or the specific portion of human body. Typical equipments are scintillation scanners and scintillation cameras. The purposes of systematizing by adding computers are as follows: 1) upgrading scintigram quality; 2) magnifying the information-expressing capability included in scintigram; 3) increasing vital function-testing ability; and 4) expansion of application to other radiation therapy program and nuclear medicine (radioimmunoassay inspection and the like). The systems realized are divided into two types, the wired program system that carries out all data processing in hardware, and the system with general use computer that processes data mainly in software. In scintillation scanners, off-line input of data to computers is preferable, while in scintillation cameras, on-line connection with computers is dominant. (JA)

3050 SOME RECOVERY PROCESS OF DETERIORATED Ge(Li) DETECTOR. Morimitsu, W. (Industrial Research Inst. of Kanagawa Prefecture, Yokohama (Japan)); Ishizuka, Y. Kanagawa-ken Kogyo Shikenjo Kenyu Hokoku; No. 41, 21-24(Nov 1974). (In Japanese)

Ge(Li) detectors are widely applied to various fields as γ-ray detectors. To maintain their properties, low temperature and high vacuum are required, and the properties deteriorate with temperature rise. Some methods were studied to recover the deteriorated properties, and favorable results were obtained. One of them is to employ clean up treatment after charging inverse bias voltage on p-i-n composite and carrying out Li^+ drift. The properties were recovered to the almost same as those of new detectors. The other method was applied when enough recovery had not been able to obtain only by the cleanup treatment. Good results were obtained by lapping off the n^+ layer which had been present, and electrolytically depositing new lithium, lithium ion drift, and cleanup treatment. (JA)

3051 TRANSMISSION SCINTIGRAPHY AND ITS APPLICATION. Nakamura, M. (Tohoku Univ., Sendai (Japan). School of Medicine). Nippon Igaku Hoshasen Gakkai Zasshi; 34: No. 9, 694-703(Sep 1974). (In Japanese)

The transmission scanning was performed to improve the anatomic orientation of the radionuclide emission scan. A γ source of ^{241}Am (300mCi) was made to move under the patient so as to follow the motion of a scintiscanner. The photons from ^{241}Am were collimated and directed through the patient to the detector. The emission and transmission radiation were separated by pulse height analysis and recorded separately. It was possible to superimpose the transmission image to the emission image with no geometric distortion. This method has been applied to

transmission images of chest, abdomen and bones. Anger et al have used ^{99m}Tc as the transmission source to get a transmission image with a scintillation camera. ^{99m}Tc could not be used for long times and should be renewed daily because of its short half life. Instead of ^{99m}Tc, a solution of 30 mCi of ^{241}Am was put into a circular container (28 cm in diameter, 1 cm thick). A multichannel collimator was placed on top of the source for producing a beam of parallel γ rays. This disc source produced chest and abdomen pictures with good quality. It was difficult to obtain images of fine structures of bones. (auth)

3052 RADIATION MEASURING APPARATUS. Okaiima, S.; Yamamoto, Y. (to Fuji Electric Co. Ltd., Tokyo (Japan)). Japanese Patent 1973-37675/B/. 20 Feb 1969. 3p. (In Japanese)

A radiation detecting method according to a conventional scanning method has, generally, a higher detection efficiency in comparison with a standard air method and a one-meter arc method in which a radiation from the patient's body is measured by a fixed detector after the patient is seated on an inclined chair or reclines on a bed. However, this method has an important defect in that the detection efficiency differs radically between the central portion of the body and both ends portions. This invention is therefore intended to eliminate the above-mentioned defect, and provides a radiation measuring apparatus which can measure with uniform detection efficiency by additionally correcting errors due to the decay rate of radiation in the body to be examined. That is, this apparatus is so constructed that the total quantity of radiation from the body can be measured by travelling a radiation detector longitudinally along the body to be examined, with the travelling rate of the detector so varied as to correct, correspondingly, the variation rate of the detection efficiency estimated by the relative position between the body to be examined and the detector, and the quantity of radiation decay. (JA)

3053 TIME CONVERSION TYPE SCINTILLATION CAMERA. Tanaka, E.; Hiramoto, T.; Nohara, N. (to National Inst. of Radiological Scences, Chiba (Japan)). Japanese Patent 1973-38275/B/. 1 Oct 1969. 3p. (In Japanese)

In a conventional Anger type scintillation camera position signal pick-up method, the output of a photomultiplier tube distantly located from a luminous point is multiplied by a large coefficient despite the small amount of information relating to the luminous point. As a result, a statistical fluctuation of the number of photoelectrons which travel to a first diode of the photomultiplier tube is excessively emphasized and the scintillation resolution is unnecessarily diminished. Therefore, to eliminate these defects, the present invention transforms the coordinates of the photomultiplier tube location to coordinates of time by applying an output signal of each photomultiplier tube to a delay wire having an intermediate tap. In addition, by suitably shaping the output waveform, interference of multiplier tubes distantly located from the luminous point is obviated to improve the resolution of the scintillation. (JA)

3054 A SCINTISCANNER. Irie, Goro; Kamiyanagi, H.; Nakanishi, S. (to Shimadzu Seisakusho Ltd., Kyoto (Japan)). Japanese Patent 1973-28514/B/. 19 Mar 1968. 7p. (In Japanese)

The present invention relates to improvements in a scintiscanner by accelerating the scanning speed. The present invention provides a scintiscanner divorced from the effects of internal organ respiration by scanning their movement and mounting an automatic compensating device. The scintiscanner comprises a bed, a scintilation scanner, a scanner transmitting a position signal related to the movement of the internal organs due to respiration, which scanner is applied for input from the output signal, and a travelling mechanism actuating either the bed or the scintillation scanner. It is designed to make periodical relative movement synchronized by the movement caused by the respiration of the patient's internal organs available between the bed and the scintillation scanner. Furthermore, the scintiscanner is characterized in that the scanner is capable of scanning geometric displacement in the respiration movement of the patient's organs and the mechanism of modulating the scanning movement of the scintillation scanner so that the scanner may travel in accordance with movement of the internal organs. It is unnecessary to carry out scanning by insisting upon the cessation of breathing. Thus the scanning is so speedy that the diagnosis can be carried out while minimizing patient discomfort. Furthermore, as it is unnecessary for the bed or a scanner to move in synchronization with respiration, it is unnecessary to mount a driving mechanism requiring a large output. (JA)

3055 SEMICONDUCTOR DETECTOR. Fujino, M. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1973-30190/B/. 30 Jun 1970. 3p. (In Japanese)

Where a depletion layer created by applying a reverse voltage to a P-N junction is exploited for detecting radioactive rays, detection is made by checking the progression of the radioactive rays in the depletion layer. Therefore, when the energy of the radioactive rays to be detected is high, it is required that the thickness of the depletion layer be large. Conventional semiconductor detectors cannot form a sufficiently thick depletion layer even by the use of a parent material of high specific resistance. A semiconductor detector according to this invention comprises a plate-shaped N-type semiconductor, P-type semiconductor layers which are respectively provided in the upper and lower surfaces of the N-type semiconductor and which have an impurity density higher than that of N-type semiconductor, and electrodes which are respectively provided on the upper P-type layer, the lower P-type layer and the side surfaces of the N-type semiconductor opposing each other, applied positive voltages V_1, V_2, V_3 and V_4 of the respective electrodes satisfying the following relations: $V_4 - V_3 \gg V_3 - V_2 = V_3 - V_1 > 0$. A depletion layer based on the P-N junction between the N-type semiconductor and the upper P-type layer and a depletion layer based on the P-N junction between the N-type semiconductor and the lower P-type layer are combined, and the resultant depletion layer achieves a large thickness. (JA)

3056 RADIATION DETECTING SEMICONDUCTOR DEVICE. Kondo, A. (to Mitsubishi Electric Corp., Tokyo (Japan)). Japanese Patent 1973-40310/B/. 26 Dec 1968. 3p. (In Japanese)

Conventional radiation detecting semiconductor devices for medical use, etc., are flat. For this reason, a surface sensitive to beams of radiation and accordingly the sensitivity of the device have a partiality to only one direction. Even when two of the devices are combined, the sensitivity is partial to only two directions. In a radiation detecting semiconductor device according to this invention, isolated semiconductor regions of a semiconductor member are of the opposite conductivity type and have a spherical surface. Each p-n junction is reverse-biased to spread depletion layers on both sides of the p-n junction. When, under this state, radioactive rays exceeding a certain energy impinge on the p-n junction, holes and electrons are created and pulses conforming to the amount of radiation are generated. By counting the number of the pulses, the amount of radiation can be determined. Since sensitivity to radiation is the highest for perpendicular impingement of the radioactive rays on the p-n junction, the maximum sensitivity is attained for the radiation from within a wide solid angle owing to the provision of the isolated p-n junctions on the spherical surface. The amount of radioactive rays impinging on the respective isolated regions can be distinguished by incorporating charge amplifiers in correspondence therewith. (JA)

3057 LINE-SCANNING PROPORTIONAL COUNTER CAMERA. Borkowski, C. J.; Kopp, M. K.; Harter, J. A. (Oak Ridge National Lab., TN). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 2, 896-900(Apr 1975).

A new method was developed for imaging spatial distributions of photons, charged particles, or neutrons over large areas by a line-scanning camera. This camera uses a linear position-sensitive proportional counter (PSPC) based on resistance-capacitance (RC) position encoding. Applications of this camera include low-dose, medium-resolution radiography of large objects (greater than 2 by 2 m); and, in nuclear medicine, low-dose, whole-body radionuclide imaging and radiography with low energy photons (less than 150 keV). A prototypic camera was built and tested to scan an area of 60 by 100 cm. The spatial resolution is 1 by 1 mm fwhm for radiography with 60-keV photons and 3 by 3 mm fwhm for radionuclide imaging with 50-keV photons (limited by collimator resolution). Compared to point-by-point scanning, the line-scanning method reduces the mechanical complexity of the camera and eliminates problems encountered in construction of large-area, high pressure PSPCs. This method is superior to the area PSPC for imaging objects greater than 60 by 60 cm. (auth)

3058 INVESTIGATION OF THE STABILIZING FACTOR OF A DISCRETE-INTEGRATION METHOD OF RECORDING RADIATION IN SCINTILLATION RADIOISOTOPE INSTRUMENTS. Belashov, V. G.; Bogachev, A. M. Meas. Tech. (USSR) (Engl. Transl.); 18: No. 3, 451-455(Mar 1975).

Translated from Izmer. Tekh.; 18: No. 3, 79-82(Mar 1975).

The measurement error is estimated for scintillation counters using the discrete recording method, and experimental data are compared with the theoretical data. (WHK)

3059 MEASUREMENT AND CALCULATION OF ABSOLUTE INTENSITIES OF X—RAY SPECTRA. Brown, D.B.; Gilfrich, J.V.; Peckerar, M.C. (Naval Research Laboratory, Washington, D. C. 20375). J. Appl. Phys. 46: No. 10, 4537-4540 (Oct 1975).

Calculations and measurement of the continuum spectra of Cr and W x-ray tubes operated at 45 kV are compared. The calculation is based on the Boltzmann transport equation and the bremsstrahlung cross

sections of Kirkpatrick and Wiedmann. The measurements use a crystal spectrometer whose efficiency is well known. The calculations and experimental data are in agreement within ±5% on a relative basis and within ±30% on an absolute basis. (auth)

Radiation Dosimeters

Refer also to abstracts 2759, 4292, and 4293.

3060 (EUR-5273d-e-f(Vol.1)) PROCEEDINGS OF SECOND SYMPOSIUM ON NEUTRON DOSIMETRY IN BIOLOGY AND MEDICINE, NEUHERBERG/MUNICH, SEPTEMBER 30-OCTOBER 4, 1974. I. Burger, G.; Ebert, H. G. (eds.). (Commission of the European Communities, Luxembourg). Mar 1975. 625p. (In several languages). (CONF-740940-P1). EUR (Vol.I and II) B.Fr. 2,000.

Separate abstracts were prepared for 12 of the 34 papers presented. The remaining 22 papers were previously abstracted in NSA and can be found in the report number index under CONF-740940. (WHK)

For abstracts of individual papers see: 3030, 3061-3064, 3162, 3167, 3168, 4292, 4293, 4511, and 4512.

3061 (EUR-5273d-e-f(Vol.1), pp 241-261) CHARACTERISTICS OF DIFFERENT IONIZATION CHAMBERS FOR FAST NEUTRON DOSIMETRY. Kuehn, H. (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Frankfurt am Main). Mar 1975.

From 2nd symposium on neutron dosimetry in biology and medicine; Neuherberg/Munich, F.R. Germany (30 Sep 1974).

In proceedings of second symposium on neutron dosimetry in biology and medicine. I.

Some characteristic features of different ionization chambers including inhomogeneous chambers employed for the determination of neutron and gamma doses are reported. Especially the influence of the wall material on the ionization within the chamber gas has been investigated by irradiating parallel plate extrapolation chambers with different gas fillings. Ratios of average mass energy absorption coefficients of some gases determined with the ionization method are compared with data from the literature for 3.3 and 15 MeV neutrons. (auth)

3062 (EUR-5273d-e-f(Vol.1), pp 302-328) INTERPRETATION IN DOSE TERMS OF IONOMETRIC MEASUREMENTS FOR NEUTRONS ((d,Be) 33 AND 50 MeV). Nguyen, V. D.; Chemtob, M.; Fache, P.; Parmentier, N.; Le Grand, J. (CEA, Fontenay-aux-Roses, France). Mar 1975. (In French).

From 2nd symposium on neutron dosimetry in biology and medicine; Neuherberg/Munich, F.R. Germany (30 Sep 1974).

In proceedings of second symposium on neutron dosimetry in biology and medicine. I.

The ionization chambers used in the Laboratoire de Dosimetrie Sanitaire for radiobiological dosimetry are tissue equivalent (walls and gas). They are calibrated in a reference beam (^{60}Co). The interpretation in dose terms of current measurements made in a beam of high-energy neutrons ((d,Be) 33 and 50 MeV) uses the ratio of the x values of $\bar{W}$ (mean energy corresponding to the creation of an ion pair in a gaseous medium) for electrons and heavy charged particles. Up to the present a constant value of 0.964 has been taken for this ratio (average value according to different authors). For high energy neutrons the problem is that of the error caused if this ratio is not corrected in order to take into account the more important contribution of the alphas and heavy recoil nuclei. In order to attempt to estimate the components due to different types of particles, the distribution functions of the dose deduced from the energy loss spectrum per event, obtained with an equivalent-tissue proportional spherical counter were used. (tr-auth)

3063 (EUR-5273d-e-f(Vol.1), pp 495-507) SENSITIVITIES OF VARIOUS THERMOLUMINESCENT, PHOTOLUMINESCENT, AND PHOTOGRAPHIC DETECTORS TO NEUTRONS. Spurny, F. (Laboratoire de Dosimetrie Radiologique, Prague); Medioni, R.; Portal, G. Mar 1975. (In French)

From 2nd symposium on neutron dosimetry in biology and medicine; Neuherberg/Munich, F.R. Germany (30 Sep 1974).

In proceedings of second symposium on neutron dosimetry in biology and medicine. I.

In mixed fields the response of photographic, radiothermoluminescent, and radiophotoluminescent detectors is altered by their sensitivity to neutrons, making corrections necessary in order to find the γ dose. The sensitivity was experimentally studied for various radiothermoluminescent (Al_2O_3, $CaSO_4$:Dy, ^{7}LiF, and LiF), radiophotoluminescent (PB 33 glasses), and photographic (Kodak-Pathe of type 1) dosimeters to thermal reactors from a swimming pool reactor and to fast neutrons produced by radioactive sources (^{252}Cf and PuBe) and by an accelerator (14.7 MeV). The effect of the type and dimensions of the containers used for the radiothermoluminescent powders was also studied in order to eliminate all parasite action. It was found that $CaSO_4$, Al_2O_3, and PB 33 glasses have the lowest sensitivity to fast neutrons. The selection of the detector for the measurement of γ doses in mixed fields will depend on the particular conditions of each experience such as the presence of thermal neutrons, the dose range, and the spectrum or relative importance of the γ radiation. (tr-auth)

3064 (EUR-5273d-e-f(Vol.1), pp 509-516) DOSIMETRY OF FAST NEUTRONS BY DENSITOMETRY. Tripier, J.; Oppel, R.; Remy, G.; Debeauvais, M. (Centre de Recherches Nucleaires, Strasbourg). Mar 1975. (In French)

From 2nd symposium on neutron dosimetry in biology and medicine; Neuherberg/Munich, F.R. Germany (30 Sep 1974).

In proceedings of second symposium on neutron dosimetry in biology and medicine. I.

An automatic readout and evaluation method is described for measuring fast neutron dose using cellulose nitrate track detectors. (WHK)

3065 PHOTOGRAPHIC DOSIMETRY: APPLICATION OF FRENCH LEGISLATION BY A SPECIALISED LABORATORY. Pierre, E. (Laboratoire Central des Industries Electriques (LCIE), 92 - Fontenay-aux-Roses (France)). pp 219-228 of 8. National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French).

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

Photographic dosimetry is at present the only method chosen by French legislation for the a posteriori supervision of personnel working under radiation. The principles of the method and the use of dosimeters are described, as a function of this French legislation on the one hand and as practised by the L. C. I. E. (Laboratoire Central des Industries Electriques) on the other. (FR)

3066 DOSIMETRY AT INTERFACES. Theoretical Analysis and Measurements by Means of Thermoluminescent LiF at Plane Interfaces Between a Low Z-Material and Al, Cu, Sn, or Pb Irradiated With 100 to 200 kV Roentgen Radiation. Carlsson, G. A. (Regionsjukhuset, Linkoeping (Sweden); Lund Univ. (Sweden). Radiofysiska Institutionen). Acta Radiol. Stockholm; Acta Radiologica (1973). 67p.

Depth dose contributions from photoelectrons and characteristic roentgen rays in low Z materials (mylar, teflon) close to foils of Al, Cu, Sn, or Pb have been measured by means of thermoluminescent LiF embedded in 0.13 mm thick teflon discs. As the detectors are thin compared to the mean free path of the photons but infinitely thick compared to the range of the secondary electrons, different methods of measurement were used in determining the depth doses within the region of electronic equilibrium and within the transition region, respectively. Within the region of electronic equilibrium the detectors were calibrated and used as dosemeters. Within the transition region, the dose distribution was resolved by successively increasing the number of thin mylar films, 0.486 mg/cm^2 thick, between the metal foil and the detector. A thorough analysis of the LiF-teflon detector is performed with special regard to the efficiency (= detector signal per unit absorbed energy), which is a function of the depth in the detector as well as varying from one individual detector to another. (SW)

3067 RADIATION QUALITY INDEPENDENT LIQUID IONIZATION CHAMBER FOR DOSIMETRY OF ELECTRON RADIATION FROM MEDICAL ACCELERATORS. Wickman, G. (Umeaa Univ. (Sweden)). Acta Radiol., Ther., Phys., Biol.; 13: No. 1, 37-48(1974).

A cylindrical ionization chamber with a layer of 0.3 mm 2,2,4-trimetylpentane used as the ionization volume has been constructed. The dosimetric properties of the detector used in electron radiation fields from medical accelerators have been investigated. (auth)

3068 MANGANESE ACTIVATED PHOSPHATE GLASS FOR DOSIMETRY. Regulla, D. (to Gesellschaft fur Strahlen-und Umweltforschung mbH). US Patent 3,899,679. 12 Aug 1975. Filed date 21 Nov 1973. 4p.

A measuring element comprises a metaphosphate glass doped with manganese as an activator. The manganese activated metaphosphate glass can detect and determine radiation doses in the range between milliroentgens and more than 10 megaroentgens. (auth)

3069 PLASTIC FOR INDICATING A RADIATION DOSE. Hori, Y.; Yoshikawa, N.; Ohmori, S. (to Nitto Electric Industrial Co., Ltd.). US Patent 3,899,677. 12 Aug 1975. Priority date 9 Jul 1968, Japan. 10p.

A plastic film suitable for indicating radiation dose contains a chlorine polymer, at least one acid sensitive coloring agent and a plasticizer. The film undergoes a distinct change of color in response to a given radiation dose, the degree of change proportional to the total change. These films may be stored for a long period without loss of sensitivity, and have good color stability after irradiation. (auth)

3070 ANNEALING OVEN FOR THERMOLUMINESCENCE DOSIMETER. Masujima, K.; Kotera, N.; Hitomi, T. (to Dai Nippon Toryo Co., Ltd.). US Patent 3,892,520. 1 Jul 1975. Priority date 10 Apr 1974, Japan. 6p.

A thermoluminescence dosimeter holder made of thermal conductive material is provided with a recess for receiving various types of thermoluminescence dosimeters without a grip and with a number of holes for receiving a rod portion of the thermoluminescence dosimeters with a grip. The thermoluminescence dosimeter holder can be pulled at least partly out of the heating box in the oven. An air space is formed between the thermoluminescence dosimeter holder and the heating box to provide a uniform temperature distribution over the thermoluminescence dosimeter holder. In a preferred embodiment, the thermoluminescence dosimeter holder is removable from the oven housing and cooled separately from the heating box. (auth)

3071 USE OF FRICKE DOSIMETER IN GAS PHASE RADIATION CHEMISTRY. Janovsky, I. (Inst. of Nuclear Research, Rez, Czech.). Radiochem. Radioanal. Lett.; 22: No. 5, 313-317 (24 Sep 1975).

Results of Fricke dosimetry and ethylene dosimetry are compared. The agreement is not satisfactory even when Bragg-Gray theory is applied. (auth)

3072 RITAD MEASUREMENTS OF SINTERED BeO DISCS. Hobzova, L.; Spurny, Z. (Faculty of Nuclear Science and Physical Engineering, Prague). Radiochem. Radioanal. Lett.; 22: No. 5, 319-323(24 Sep 1975).

The new radiation-physics phenomenon "radiation induced thermally activated depolarization" (RITAD) has been successfully applied to radiation dosimetry. Using BeO tablets "Thermalox 995", the curves of internal depolarization were easily measured beginning with some $J.kg^{-1}$ of absorbed doses. The advantage of this type of solid-state dosimeter is based on the simplification of read-out technique. (auth)

3073 ENERGY TRANSFER TO SOME TLD MATERIALS BY NEUTRONS, RELATIVE KERMA TO TISSUE. Spurny, F. (Lab. for Radiological Dosimetry, Prague). Radiochem. Radioanal. Lett.; 22: No. 5, 325-330(24 Sep 1975).

Calculation of kerma for neutrons of the energies between 0.01 and 18 MeV have been carried out for several commonly used thermoluminescent materials, i.e. ^{6}LiF, ^{nat}LiF, ^{7}LiF, BeO, Al_2O_3, and $CaSO_4$. The values obtained are compared with the kerma in tissue. With the exception of ^{6}LiF in the region of neutron energies below 0.5 MeV, kerma in TLD materials is generally much smaller than in tissue: this is one of the reasons for low relative response of the studied TLD materials to fast neutrons. (auth)

3074 POSSIBILITY OF USING SUCCINIC ACID FOR THE DOSE RATE DETERMINATION OF REACTOR RADIATION. Bartonicek, B.; Pejsa, R.; Stetka, R. (Inst. of Nuclear Research, Rez, Czech.). Radiochem. Radioanal. Lett.; 22: No. 5, 331-334 (24 Sep 1975).

The possibility of the determination of dose rate of reactor radiation is described. The determination is based on the measurement of pressure of gases formed by radiolysis of succinic acid. A device, which makes it possible to measure the pressure of gases with a high precision, is shown. (auth)

3075 EMPIRICAL METHODS OF USING SOILS AS RADIATION DOSIMETERS. Nishita, H.; Hamilton, M. (Univ. of California, Los Angeles). Soil Sci.; 120: No. 20, 96-106(Aug 1975).

Two empirical methods of using soils as ionizing radiation dosimeters are presented. These methods were derived through the use of the thermoluminescence characteristics of soils. Method A was designed for irradiated soils for which preirradiation collection of the soils was available. This method is workable for maximum radiation exposure levels up to about 480,000 roentgens. Method B was designed for irradiated soils for which preirradiation collection of them was not available. This method is workable for maximum radiation exposure levels up to about 5,000 roentgens. Some of the reasons for the discrepancy in the sensitivity between the two methods are discussed. Various factors that influence the measurement of soil thermoluminescence are discussed also. (auth)

3076 METHOD OF TRANSFERRING THE SIZE OF THE UNIT OF ABSORBED DOSE INTENSITY FROM THE STATE PRIMARY STANDARD TO A STANDARD FACILITY FOR MEASURING THE ABSORBED DOSE OF γ RADIATION FROM ^{60}Co IN MUSCLE TISSUE. Bregadze, Yu. I.; Muratov, N. I.; Tultaev, A. V. Meas. Tech. (USSR) (Engl. Transl.); 18: No. 3, 444-446 (Mar 1975).

Translated from Izmer. Tekh.; 18: No. 3, 75-77(Mar 1975).

The state primary standard consists of a ^{60}Co γ source and a graphite phantom with a calorimeter. A method for calibrating working standards using a tissue-equivalent phantom containing a thin walled thimble ionization chamber is described. (WHK)

3077 QUO VADIS, PERSONNEL MONITORING. Becker, K. (Oak Ridge National Lab., TN). Nucl. Saf.; 16: No. 6, 728-733 (1975).

With the increasing use of nuclear power and radiation sources, the selection of optimum systems for personnel monitoring is becoming a matter of worldwide concern. The present status of personnel dosimetry, sometimes characterized by unstable and inaccurate detectors and oversimplified interpretation of the results, leaves much to be desired. In particular, photographic film, although having certain advantages with regard to economics and information content, undergoes rapid changes in warm and humid climates. Careful sealing reduces, but does not prevent, these problems. The replacement of film by solid-state dosimeters, primarily thermoluminescence dosimeters, is in progress or being considered by an increasing number of institutions and requires a number of decisions concerning the choice of the optimum detector(s), badge design, and evaluation system; organizational matters, such as the desirability of automation and computerized bookkeeping; etc. The change also implies the potential use of such advanced concepts as different detectors and monitoring periods for the large number of low-risk persons and the small number of high-risk radiation workers. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 3036, 4535, 4940, and 4941.

3078 (AERE-R-8085) IMPROVED COMPUTER CONTROLLED TRIPLE-AXIS NEUTRON SPECTROMETER. Cooper, M. J.; Hall, J. W.; Hutchings, M. T. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Jul 1975. 27p. Dep. NTIS (US Sales Only) $5.00. £1.00.

A description is given of the computer-controlled triple-axis neutron spectrometer installed at the PLUTO reactor at Harwell. The reasons for and nature of recent major improvements are discussed. Following a general description of the spectrometer, details are then given of the new computerised control system, including the functions of the various programs which are now available to the user. (auth)

3079 (AERE-R-8098) DEVELOPMENT OF COMPUTING FACILITIES FOR THE NEUTRON BEAM EXPERIMENTS AT HARWELL. Cooper, M. J.; Harris, D. H. C.; Pawley, G. S.; Rainford, B. D.; Stirling, G. C.; Wright, S. B. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Jul 1975. 16p. Dep. NTIS (US Sales Only) $4.50. £1.00.

This report presents the conclusions of a Working Group set up to consider the development of computing facilities for the neutron beam experiments at Harwell. It is proposed that a linked computer system should be set up containing one fairly large "hub" computer, capable of executing programs in FORTRAN and of supporting a wide range of peripherals, and a number of small "control" computers interfaced to specific instruments. The control computers should be only loosely coupled to the "hub" computer by standard asynchronous teletype-like links, in order to provide safeguards against accidental interference with individual experiments and to ensure as far as possible continued running of the control computers when the "hub" is unavailable. The main benefits from such a system will arise in automating new instruments and in refurbishing existing systems more cheaply than at present and in the provision of better, more flexible, facilities and greater efficiency. The requirements for the "hub" computer have been considered in detail and it is concluded that, at the present time, the most suitable type of "hub" computer system would be one based on a computer at the small end of the "large" computer range. (auth)

3080 (INIS-mf-1698, pp 237-242) IMITATION OF PSEUDO-ACCIDENTAL METHOD OF NEUTRON SPECTROMETRY WITH AID OF PULSED SOURCES. Muradyan, V. G.; Adamchuk, Yu. V.; Shchepkin, Yu. G.; Voskanyan, M. A.; Ustroev, G. I. 1974. (In Russian)

From 2nd all-union conference on neutron physics; Obninsk, USSR (3 Mar 1974).

In neutron physics. Part 4. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.).

This study presents a comparison of neutron spectrometry methods "AB" and "A", where "AB" is intermediate between the classical, time-of-flight method (method "A") and a pseudo-random method (method "B"). During measurements of cross sections with evenly separated peaks the "AB" method turns out to be more efficient than the "A" method. (tr-SJR)

3081 (LBL-4000, pp 380-382) MODIFIED ^{8}Be IDENTIFIER. Wozniak, G. J. (Nuclear Structure Lab., Oxford); Jelley, N. A.; Cerny, J. Jul 1975.

In nuclear chemistry. Annual report 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

3082 (NP-20526, pp 17-18) ENERGY LOSS OF 2 MeV ELECTRON IN THICK ABSORBER. Fujita, Y.; Kawakami, H.; Sanada, J. 1974.

In Institute for Nuclear Study annual report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

3083 (NP-20526, pp 115-116) REDUCTION OF BACKGROUND GAMMA-RAYS IN A LOW LEVEL GAMMA-RAY SPECTROMETER. Hasebe, N.; Sugiyama, T.; Kikuchi, J.; Doke, T. (Waseda Univ., Japan). 1974.

In Institute for Nuclear Study annual report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

3084 INELASTIC ELECTRON SCATTERING SPECTROMETER. Gibbons, P.C.; Ritsko, J.J.; Schnatterly, S.E. (Joseph Henry Laboratories, Princeton University, Princeton, New Jersey 08540). Rev. Sci. Instrum. 46: No. 11, 1546-1554 (Nov 1975).

The design and construction of an inelastic electron scattering spectrometer for the study of electronic excitations of solids is described. The spectrometer features high beam energy (300 keV) and fine energy loss resolution (<0.1 eV). Energy loss spectra in the range 0-1000 eV may be measured with momentum transfer from 0 to 2 A^{-1}. (auth)

3085 FORMATION OF THE PULSE-HEIGHT SPECTRUM OF DIAMOND DETECTORS IRRADIATED WITH ELECTRONS. Kozlov, S. F.; Katkov, V. P.; Krupman, A. J. (Lebedev Inst. of Physics, Moscow). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 2, 901-904 (Apr 1975).

The pulse-height spectrum of the diamond detectors irradiated with conversion electrons from ^{109}Cd source (Eo equals 84 keV) is calculated. The energy losses of electrons are taken into account with the help of an empirical expression that connects the range with the energy. The comparison with experimental data allowed to estimate the parameter of the detector material, i.e., the value NS equals 10^{-4} cm^{-1}. (auth)

3086 ERROR IN MEASURING THE ENERGY OF α PARTICLES IN A SEMICONDUCTOR SPECTROMETER. Stepanov, E. K. Meas. Tech. (USSR) (Engl. Transl.); 18: No. 3, 447-450 (Mar 1975).

Translated from Izmer. Tekh.; 18: No. 3, 77-79 (Mar 1975).

The measurement of α-particle energies in semiconductor spectrometers is based on a comparison of the position of the spectrograms of the α sources being investigated with reference spectrometric sources, by means of which the energy calibration of the spectrometer is carried out. When measuring α-particle energies, there are errors which are of a random nature as well as of a systematic nature. (auth)

High Energy Physics Instrumentation

Refer also to abstract 3716.

3087 (CEA-CONF-3088) ISOTOPIC ANALYSIS BY SLOWING-DOWN CHERENKOV-CHERENKOV METHOD. Meyer, J. P.; Gaulier, F. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). 1975. 6p. (CONF-750805-12). Dep. NTIS (US Sales Only) $4.00.

From 14th international cosmic ray conference; Munich, F.R. Germany (15 Aug 1975).

Detailed calculations of the expected performance of a large geometry Cherenkov-Cherenkov slowing-down setup for isotopic analysis in the 1 to 2 GeV/n region are presented. Such a setup should permit isotope analysis of all elements between neon and nickel with r.m.s. mass errors < 0.33, < 0.50 and < 1 AMU over respectively ≈ 175, ≈ 250 and ≈ 500 MeV/n wide energy ranges. The background associated with the very high rate of nuclear interactions in the instrument (75%) should be eliminated by a triple redundancy in the charge measurement. These estimates are largely based on experience from Danish-French balloon flights and from runs at the Berkeley Bevatron. (auth)

3088 (CEA-N-1800) PROGRAMMING SYSTEM FOR BUBBLE CHAMBER PHOTOGRAPHS MEASURING TABLES ON LINE TO A COMPUTER. Miche, R. (CEA Centre d'Etudes Nucleaires de Saclay, 91-Gif-sur-Yvette (France). Dept. de Physique des Particules Elementaires). Jun 1975. 259p. (In French). Dep. NTIS (US Sales Only) $10.00.

The aim of this paper is to present the study and practical realization of a programming system available on an industrial computer, type PDP 15/20, performing the exploitation of bubble chamber pictures with the projection tables on line to the computer. This system must suit the particular conditions met in the analysis of photographs from different bubble chambers, the different stages for dealing with the views (scanning, pre-measurement, measurement) adapting to different strategies in the handling of measurements. The exploitation of photographs takes place in a conversational mode to which a concrete form is given by sending messages to the operators at the tables and by receiving coded answers. In this framework, the aims of the operating system are: to guide the operators' work at the tables while allowing them to interrupt the normal sequence of events, to carry out some elementary logical checks, and to write on magnetic tape the checked data with the appropriate labels as required. (auth)

3089 (CERN-75-12) 256-CHANNEL PULSE-HEIGHT ANALYSER. Berset, J. C.; Delavallade, G.; Lindsay, J. (European Organization for Nuclear Research, Geneva (Switzerland)). 13 Oct 1975. 21p. Dep. NTIS (US Sales Only) $4.50.

The design, construction, and testing of a small, low-cost 256-channel pulse-height analyser is briefly discussed. The analyser, intended for use in the setting up of experiments in high-energy physics, is fully compatible with the CERN/NIM nucleonic instrumentation. It has a digital display of channel and content as well as outputs for printing, plotting, and binary transfer. The logic circuitry is made with TTL integrated circuits and has a static random-access MOS memory. Logic and timing diagrams are given. Detailed specifications are also included. (auth)

3090 (CONF-751116-1) TWO-PHASE FLUID DENSITY MEASUREMENT WITH A TWO-BEAM RADIATION DENSITOMETER. Lassahn, G. D. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). 1975. 6p.

From nuclear science symposium; San Francisco, California, USA (19 Nov 1975).

A densitometer consisting of two beams of radiation passing through a pipe is very useful for measuring the average density and the density distribution of inhomogeneous two-phase fluids in the pipe. The general technique is illustrated by an example. (auth)

3091 (JINR-P10-8860) CONTROLLING AND RECOGNIZING PROGRAM COMPLEX FOR A SCANNING DEVICE WITH A MONITORING SYSTEM OF MAN-MACHINE DIALOGUE. Barashenkova, N. V.; Karlov, A. A.; Lapchik, E. D.; Senchenko, V. A.; Tutyshkina, L. V.; Shkundenkov, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 15p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

A program complex is described for an AELT-I scanning device, which is intended for 35 mm film processing and is used for a wide-gap spark chamber picture processing. High efficiency of picture processing has been achieved due to the application of the monitoring system with man-machine dialogue. (auth)

3092 (JINR-P10-8861) AELT-2/160 MONITORING SCANNING DEVICE. Baranchuk, M. K.; Barashenkova, N. V.; Gusev, Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 15p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

An AELT-2/160 scanning device with a computer controlled CRT as a basis is described. The device is intended for processing large frame pictures (160 mm along diagonal). BESM-4 and CDC-6200 computers are used for data processing. It has a monitoring system of man-machine dialogue. (auth)

3093 (ORNL-TM-5118) CALCULATED PERFORMANCE OF A SEGMENTED PYRAMID-SHAPED CALORIMETER OF IRON AND PLASTIC. Amburgey, J. D.; Gabriel, T. A. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 25p. Dep. NTIS $4.00.

The calculated performance of a segmented pyramid-shaped calorimeter of iron and plastic is presented. The types of incident particles considered are protons, charged pions, and electrons. The momentum range is 0.2 to 8 GeV/c. The calculated resolution (DELTA E/E) obtained for protons and charged pions decreases from approximately 90 percent at 1 GeV to approximately 50 percent at 8 GeV. For incident electrons, the resolution decreases from approximately 25 percent at 1 GeV to approximately 8 percent at 8 GeV. (auth)

3094 (RL-75-135) FIRST OBSERVATION OF THE RELATIVISTIC RISE IN BUBBLE DENSITY IN A NEON–HYDROGEN BUBBLE CHAMBER. Fisher, C. M.; Guy, J. G.; Venus, W. A. (Science Research Council, Chilton (UK). Rutherford Lab.). 1975. 17p. Dep. NTIS (US Sales Only) $4.50.

In a bubble chamber containing a neon-hydrogen mixture surrounding a hydrogen-filled track sensitive target, electrons with momenta above 100 MeV/c are observed to have 1.25 ± 0.02 times more bubbles per unit length in neon-hydrogen than pions with momenta between 400 and 1500 MeV/c. We interpret this difference as due to a relativistic rise in bubble density, such as has been observed previously in a freon bubble chamber. The total magnitude of the rise from minimum to plateau is estimated to be 28 ± 2%. This should provide a method for distinguishing between relativistic pions, kaons and protons of the same momentum. It could in particular be exploited in high energy experiments using the track sensitive target technique in large bubble chambers such as BEBC. (auth)

3095 ENERGY DETERMINATION OF HIGH ENERGY CASCADE SHOWER OBSERVED WITH EMULSION CHAMBER WITH A PHOTOMETER. Ohta, I. (Utsunomiya Univ. (Japan). Faculty of Education); Kasahara, K.; Kobayashi, T.; Mikumo, E.; Mito, I. Uchusen Kenkyu; 18: No. 4, 345-383(Jun 1974). (In Japanese)

The RR type x-ray film having smaller silver grain as compared with N type film has come to be used recently for measuring the energy of cosmic showers. Employment of the film with small silver grain has been necessitated by carrying out density measurements using a slit as large as possible because of the demand to determine the shower energy only at the initial stage of shower growth. First, the characteristics of the N type and the RR type x-ray films are compared. Calculation of the degree of darkening for various factors was performed, taking oblique incidence into consideration. Next, the relation between shower energy E and the degree of D_{max} of the N type and the RR type film is determined, and the determination of shower energy in the case of largely inclined is compared with experimental results. Finally, consideration on the energy determination by photometry is described for thick and thin emulsion chambers. In appendixes, the relation among electron density ρ, silver grain density N, and the degree of darkening D, and the calculation of the degree of darkening in case of inclined incidence to film are explained. (JA)

3096 METHOD OF MANUFACTURING THE SPARK CHAMBER. Goto, Eizo. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1973-42197/B/. 19 Sep 1969. 5p. (In Japanese)

A prior-art spark chamber for detecting radiation is constructed within a hermetically sealed vessel having a gas inlet and a gas outlet in which a pair of electrode plates of glass are opposed through a spacer in such manner that electrodes face each other in parallel. When using the spark chamber, a gas for discharge must be caused to flow through the vessel. Therefore, a gas bomb or the like is required, and handling is difficult. According to this invention, a spark chamber is manufactured in such a way that the peripheral portions of the electrode plates are secured by glass fusion welding so as to form a closed body and so that the closed body is filled with the discharge gas or vapor. Owing to the hermetically sealed structure, handling is facilitated and discharge stabilized. (JA)

3097 DRIFT CHAMBER APPLICATION IN HIGH ENERGY PHYSICS. Sadoulet, B. (Univ. of California, Berkeley). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 2, 892-895(Apr 1975).

The use of drift chambers in the field of high energy physics is reviewed including existing apparatus, plans and dreams. Comments are made especially on low cost large area drift chambers, use of pulse height information and high spatial resolution applications. (auth)

Radiometric Instruments

Refer also to abstracts 3148 and 3479.

3098 DEVICE FOR THE DETERMINATION OF CONCENTRATIONS OF FISSILE AND/OR FERTILE MATERIALS BY MEANS OF X-RAY FLUORESCENCE SPECTROMETRY. Von Baeckmann, A.; Neuber, J. (to Gesellschaft fuer Kernforschung m.b.H.). US Patent 3,879,609. 22 Apr 1975. Priority date 20 Sep 1971, F. R. Germany. 6p.

In analyzing fissile and/or fertile materials in the thorium, uranium, neptunium, plutonium, americium and curium group, time and accuracy are significant factors. An automated system for rapidly analyzing these materials includes: sample preparation device in which aliquots of sample are weighed and mixed with known amounts of solution; x-ray fluorescence spectrometer; and, a central control system for controlling the operation and analyzing the data. (auth)

3099 TWO DETECTOR PULSE NEUTRON LOGGING POROSITY TECHNIQUE. Schwartz, R. J. (to Schlumberger Technology Corp.). US Patent 3,621,255. 16 Nov 1971. Filed date 2 Oct 1969. 6p.

An illustrative embodiment of the invention discloses a technique for reducing the influence of borehole characteristics on earth formation porosity measurements. Measurements of this sort are accomplished with a borehole logging tool and comprises two neutron detectors spaced at different distances from a pulsed neutron generator. The thermal neutron decay time of the short-spaced detector identifies that portion of the time-dependent population that is most indicative of the formation porosity. Both detectors then register the portion of the neutron distribution so identified to produce two signals from which a ratio is computed that is related to the porosity of the formation. (auth)

3100 DUAL SCINTILLATION DETECTOR, SINGLE PHOTOMULTIPLIER DENSITY LOGGING SYSTEM. Paap, H. J. (to Texaco Inc.). US Patent 3,882,309. 6 May 1975. Filed date 30 Jul 1973. 8p.

An illustrative embodiment of the invention includes a gamma ray density logging system utilizing a well logging sonde having two longitudinally spaced scintillation type gamma ray detectors having different phosphor decay constant characteristics. The dual detectors are optically coupled by a high density lead glass pipe which also acts as a gamma ray shielding material. A single photomultiplier observes both scintillation crystals and transmits voltage pulses representative of scintillations from both crystals to the surface where they are separated by pulse shape discrimination techniques to produce a dual detector compensated density log. (auth)

3101 NEUTRON LOGGING RELIABILITY TECHNIQUES AND APPARATUS. Johnstone, C. W. (to Schlumberger Technology Corp.). US Patent 3,890,501. 17 Jun 1975. Filed date 1 May 1973. 22p.

Apparatus and methods for verifying the validity of data derived at least in part by neutron logging of earth formations, and, where indicated, for affording neutron diffusion-corrected values of such data, are disclosed. (WHK)

3102 FAST NEUTRON AUTOMATIC ACTIVATION SYSTEM. Amemiya, S.; Itoh, M.; Kawade, K.; Yamamoto, H., Katoh, T. (Nagoya Univ. (Japan). Faculty of Engineering). J. Nucl. Sci. Technol. (Tokyo); 11: No. 9, 395-402(Sep 1974).

A fast neutron irradiation system was designed for performing activation analyses with fast neutrons on elements producing short-lived nuclides. The system consists of a Van de Graaff accelerator, a pneumatic transfer system, a γ-ray detection system and a control system. All the process steps of the activation analysis, such as irradiation, transfer of the sample and measurement of γ-rays are carried out in automatic sequence, governed by a programmed control system. The main part of this paper is devoted to a description of this control system. The apparatus was successfully tried for the analysis of ^{207m}Pb ($T_{\frac{1}{2}}$ = 0.797 sec). The activity was identified with the apparatus set to measure half-life. Background can be reduced by selecting the time sequence of analyzing processes. (auth)

3103 STUDIES ON THE LEAF BURN IN PYRUS SPP., 2. Moisture Changes in the Burning Leaf of Bartlett Pear. Kumashiro, K.; Sato, Y.; Tateishi, S. (Shinshu Univ., Nagano (Japan)). Engei Gakkai Zasshi; 42: No. 4, 305-309(Mar 1974). (In Japanese)

The water content and the water saturation deficit of burning Bartlett pear leaves were compared with those of healthy ones, since the leaf burn seemed to be caused by desiccation resulted from excessive transpiration. The water content expressed as percent of fresh weight of severely burning leaves was somewhat lower, although no appreciable difference existed between those of slightly burning and healthy leaves. However, the water saturation deficit of burning leaves was apparently higher, even when they were slightly injured. There was observed a significant linear correlation between affected area and water saturation deficit of burning leaves. In order to determine the change of water content at localized areas of Bartlett pear leaves continuously, the β ray gauging technique was attempted. In a preliminary examination with detached leaves, the log. of the relative intensity of transmitted β rays increased linearly, as water content of the leaf decreased and water saturation deficit of the leaf increased. And among ^{14}C, ^{147}Pm, and ^{204}Tl used as the β ray source, ^{147}Pm was the most suitable for measuring moisture change of Bartlett pear leaves. Based on the result of the measurement of moisture content in the intact Bartlett pear leaf by

the β ray gauging technique, it was concluded that the relative intensity of transmitted β rays increased prior to the occurrence of burning symptoms. This suggests that the leaf burn of the Bartlett pear is caused by dehydration of the leaf tissues. (auth)

3104 LIQUID LEVEL CONTROL USING γ-RAY RELAYS. Wakabayashi, N. (Kobe Univ., Japan). Trans. Soc. Instrum. Contr. Eng.; 11: No. 1, 45-50(Feb 1975). (In Japanese)

Using a control action which consists of constant infusing and exhausting speeds and a neutral zone to maintain liquid level within a given range, a γ-ray source, a detector and two relays at the upper and lower limits of the counting rate are provided. The optimum condition in this case is discussed and ensured experimentally. (WHK)

Radiation Effects on Instrument Components, Instruments, or Electronic Systems

3105 (HMI-B-181) RADIATION BURDEN STUDIES ON ELECTRONIC COMPONENTS OF THE SYMPHONIE SATELLITE. Spencker, A.; Wagemann, H. G.; Braeunig, D. (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (F.R. Germany)). Sep 1975. 125p. (In German). Dep. NTIS (US Sales Only) $6.50.

This report surveys fundamentals, realization and results of irradiation experiments which applied to 36 different electronic components of the Symphonie satellite and which were completed at the HMI Berlin and the C.N.E.T. Lannion in the years 1972/73. In a general selection the evaluation of equivalent fluencies concerning 1 MeV electrons as radiation simulating the extraterrestric particle spectra with regard to the well-known semiconductor damage mechanisms is discussed. Then the realization of irradiation testing for the Symphonie satellite is described. Three selected examples demonstrate typical failure modes of semiconductor devices under radiation stress. Finally the main experimental results are shown in a standardized manner. (auth)

3106 (PEM-37) SOME HANDBOOK REFERENCES AND A SUMMARY FOR "EMP ENGINEERING AND DESIGN PRINCIPLES". Martin, L. C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1975. 6p. Dep. NTIS $4.50.

The material in this note contains a number of handbook-oriented references and also constitutes a brief review and summary for the copyrighted publication "EMP Engineering and Design Principles," a book by the Electrical Protection Department, Loop Transmission Division, Bell Telephone Laboratories, Incorporated, Whippany, New Jersey; copyrighted 1975. (WHK)

3107 (PEM-40) INTERFACE CIRCUIT PROTECTION IN SATELLITE APPLICATIONS. Sheppard, T. J. (TRW Systems Group, Redondo Beach, Calif. (USA)). Jul 1975. 24p. Dep. NTIS $4.50.

EMP and radiation-induced electrical transients generated on the interconnect cables can cause severe damage or burnout of sensitive active components. Protection of interface circuitry in weight critical systems such as satellites can best be achieved by the addition of discrete voltage clamps, current limiters or filters. Design engineers, aware of these techniques, can include this type of protection in initial circuit designs and consequently eliminate any redesign for hardness. (auth)

3108 EFFECTS OF IRRADIATION ON HIGH-EFFICIENCY SILICON SOLAR CELLS. Nguyen Duy, T. (Societe Anonyme des Telecommunications, Paris); Amingual, D.; Colardelle, P.; Bernard, J. pp 651-657 of Evaluation of the Effect of the Space Environment on Materials. Paris; Centre National d'Etudes Spatiales (1974). (In French)

From conference on evaluation of the effect of the space environment on materials; Toulouse, France (17 Jun 1974).

By optimizing the diffusion parameters, high-efficiency cells were obtained from 2 ohm-cm (13.5 per cent AMO) and 10 ohm-cm (12.5 per cent AMO) silicon material. These new cells have been subjected to irradiation by 1-MeV and 2-MeV electrons and 2.5-MeV protons. Their behavior under irradiation is found to depend only on the bulk material. When silicon of the same resistivity is used, the rate of degradation is exactly the same as that of conventional cells. The power increase, due to better superficial response of the cell, is maintained after irradiation. These results show that new high-efficiency cells offer an end-of-life power higher than that of conventional cells. (auth)

3109 RADIATION DOSE-RATE DEPENDENCY IN SATELLITE OSCILLATORS AND SOLAR CELLS. Faraday, B. J.; Statler, R. L. (Naval Research Lab., Washington, DC). pp 831-843 of Evaluation of the Effect of the Space Environment on Materials. Paris; Centre National d'Etudes Spatiales (1974).

From conference on evaluation of the effect of the space environment on materials; Toulouse, France (17 Jun 1974).

The effects of radiation on some external and internal components of satellites were studied experimentally. Lithium-doped solar cells were irradiated (to the same total integrated fluence) with Co-60 gamma rays at a rate comparable with the Van Allen radiation environment, and also with 1 MeV electrons at a dose rate higher by orders of magnitude. Measurement of the photovoltaic current-voltage characteristic with a solar simulator showed that the irradiation at the lower dose rate produced more damage. Likewise, quartz oscillators (used as frequency control devices) were irradiated by Co-60 gamma rays at various dose rates to the same total absorbed dose. Measurement of the radiation induced decrease in resonant frequency showed that the degradation was strongly influenced by the dose rate for exposures comparable with those received in space over a period of several years. (IAA)

3110 IMPROVEMENT OF THE RESISTANCE TO RADIATION OF BIPOLAR SILICON PLANAR TRANSISTORS. Bauerlein, R. (Siemens AG, Erlangen, Ger.). pp 723-735 of Evaluation of the Effect of the Space Environment on Materials. Paris; Centre National d'Etudes Spatiales (1974).

From conference on evaluation of the effect of the space environment on materials; Toulouse, France (17 Jun 1974).

A process is reported with which the ionization damage of bipolar silicon planar transistors can be greatly reduced. This process consists of irradiation-temperature treatment for prepared transistor units (dose 1-10 billion rad, temperature 200-300 C) followed by a bias-temperature treatment to complete the annealing of the radiation damage produced by the preceding step. With this hardening process, n-p-n transistors are more suitable than p-n-p transistors. The results are shown for two types of silicon n-p-n transistors. One type has a very thin base region and, hence, is already insensitive to displacement damage. The physical reasons for the improvement effect are also discussed. (auth)

3111 OPTIMISATION OF SOLAR CELL SHIELDING FOR GEOSTATIONARY MISSIONS. Walkden, M. W. pp 697-715 of Evaluation of the Effect of the Space Environment on Materials. Paris; Centre National d'Etudes Spatiales (1974).

From conference on evaluation of the effect of the space environment on materials; Toulouse, France (17 Jun 1974).

Equivalent 1-MeV electron fluences, end-of-life output powers, and power-to-weight ratios are estimated for solar cells in a five-year geostationary mission beginning in 1975. The study covers cell thicknesses from 125 microns to 300 microns, coverslip thicknesses from 25 microns to 300 microns, rear shielding typical of rigid and lightweight flexible arrays, and infinite rear shielding. It is concluded that the thinnest cells and shielding give the best power-to-weight ratio, although the choice for a particular spacecraft will be influenced by considerations of availability, cost, fragility, and array area. (auth)

3112 SIMULTANEOUS ELECTRON-PHOTON IRRADIATION OF CRUCIBLE GROWN AND FLOAT-ZONE SILICON SOLAR CELLS. Bernard, J. (Centre d'Etudes et de Recherches, Toulouse); Crabb, R. L. pp 639-650 of Evaluation of the Effect of the Space Environment on Materials. Paris; Centre National d'Etudes Spatiales (1974).

From conference on evaluation of the effect of the space environment on materials; Toulouse, France (17 Jun 1974).

A chamber is described which can be used for simultaneous exposures to electrons, protons, and photons, and also for in situ measurements of such solar-cell parameters as diffusion length and current-voltage characteristic. Results obtained by exposing 10-Ohm-cm n-p solar cells made of two types of silicon crystal to the simultaneous effect of electrons and photons are discussed. (IAA)

3113 COMBINED EFFECTS OF ELECTRON AND PHOTON IRRADIATION ON THE DEGRADATION OF SILICON SOLAR CELLS. Gasset, G.; Munoz, L. C.; Bielle-Daspet, D. (Univ., Toulouse). pp 607-625 of Evaluation of the Effect of the Space Environment on Materials. Paris; Centre National d'Etudes Spatiales (1974). (In French)

From conference on evaluation of the effect of the space environment on materials; Toulouse, France (17 Jun 1974).

The effects of successive irradiations by photons and 1-MeV and 4.5-MeV electrons on the degradation of the base of silicon cells are determined from their effects on the minority carrier lifetime in the base. The resulting damage is analyzed on the basis of the dependence of minority carrier lifetime on carrier injection rate, of the annealing temperature, and of the properties of the silicon employed. (IAA)

3114 INVESTIGATION OF SOLAR CELL RADIATION DAMAGE. Bernard, J. Reulet, R.; Arndt, R. A. (Centre d'Etudes et de Recherches, Toulouse). pp 675-684 of Evaluation of the Effect of the Space Environment on Materials. Paris; Centre National d'Etudes Spatiales (1974).

From conference on evaluation of the effect of the space environment on materials; Toulouse, France (17 Jun 1974).

A facility for studying the influence of space radiations on the lifetime of solar arrays is described, in which the test samples are made to move past electron, proton, and photon sources. Measurement of such parameters as current-voltage characteristic, minority-carrier diffusion length, and window transmission, are carried out in vacuum immediately after irradiation. Results obtained for silicon cells and CdS thin film cells and for their cover materials are examined. (IAA)

3115 INFLUENCE OF SOLAR CELL BASE MATERIAL ON HIGH ENERGY PARTICLE DEGRADATION. Bebermeier, H.; Schulz, B. (Telefunken AG, Wedel, Ger.). pp 659-673 of Evaluation of the Effect of the Space Environment on Materials. Paris; Centre National d'Etudes Spatiales (1974).

From conference on evaluation of the effect of the space environment on materials; Toulouse, France (17 Jun 1974).

Nineteen different solar-cell types have been subjected to an extensive electron-irradiation program, and their degradation has been investigated as a function of the temperature and the radiation dose. Uncovered solar cells were subjected to radiation flux levels up to 5000 trillion 1-MeV electrons per sq cm. The electrical characteristics of the cells were measured between −60 C and +100 C. (auth)

3116 RADIATION EFFECTS ON HIGH EFFICIENCY SILICON-SOLAR CELLS. Luft, W. (TRW Systems Group, Redondo Beach, CA). pp 627-638 of Evaluation of the Effect of the Space Environment on Materials. Paris; Centre National d'Etudes Spatiales (1974).

Fron conference on evaluation of the effect of the space environment on materials; Toulouse, France (17 Jun 1974).

Three manufacturers in the U.S. are producing high-efficiency cells with enhanced response for short-wave radiation (0.3-0.5 micron). These cells differ in design (base resistivity, backfield, grid lines, etc.) and manufacturing processes. Basic characterizations of the electrical parameters are presented, including current-voltage characteristics, spectral response, and temperature coefficients. The performance data are given for two types of covers, namely, fused silica with a 350-nm ultraviolet reflection filter and 5-%-CeO-doped glass. The cells were subjected to 1-MeV electron irradiation to determine the degradation characteristics of the short-circuit current, the open-circuit voltage, and the maximum power. These data are compared to silicon solar-cell characteristics. In a study of such degradation, the spectrum of the light source and its calibration are of paramount importance for accuracy in the data. High-efficiency cells were calibrated by a high-altitude balloon flight. These cells were then used for light-flux calibration using both continuous and pulsed xenon solar simulators. The spectra were measured with a spectroradiometer. (IAA)

3117 ELECTRICAL AND IRRADIATION PERFORMANCE OF MNOS ARRAYS. Kim, M. J.; Doyle, J. T.; Patterson, W. J.; Pajak, R. W. (General Electric Co., Syracuse, N. Y. (USA)). Jpn. J. Appl. Phys.; 13: No. 11, 1837-1846(Nov 1974).

This paper describes the methods used to evaluate and characterize MNOS arrays and includes test data on the most important parameters of such arrays from the standpoint of large systems. MNOS 256-bit and 2240-bit charge storage memory arrays are evaluated, primarily, in terms of switching speed, level separation uniformity across the chip, nonvolatility, adjacent word disturb during writing, and the effects of temperature and γ-radiation. For a 2240-bit array, a minimum level separation of more than 5 volts across the chip was obtained using a 30 volt pulse with a one millisecond pulse width for writing and erasing and a read cycle time of 500 ns. The information can be stored for more than 10 years. The adjacent word disturb was less than 3% after 20,000 successive write-clear cycles and it was not cumulative. There was no degradation of the cell after 10^9 successive cycles. In the temperature range -55 to +125°C, there was little degradation in the writing, erasing and storage characteristics. Useful information can be stored at radiation levels of up to 5×10^5 Rads (Si). The window is completely closed after a dosage of 10^6 Rads (Si), in good agreement with the model developed during this study. (auth)

Miscellaneous Instruments

Refer also to abstracts 2948 and 3128.

3118 (LBL-4000, pp 376) DIGITAL THERMOELECTRIC BEAM POWER METER. Nitschke, J. M. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

3119 (LBL-4219) OPTICAL TIMING RECEIVER FOR THE NASA LASER RANGING SYSTEM. Part I. Constant-Fraction Discriminator. Leskovar, B.; Lo, C. C. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 14 Aug 1975. Contract W-7405-Eng-48. 25p. Dep. NTIS $4.00.

Position-resolution capabilities of the NASA laser ranging system are essentially determined by time-resolution capabilities of its optical timing receiver. The optical timing receiver consists of a fast photoelectric device, primarily a standard of microchannel-plate-type photomultiplier or an avalanche photodiode detector, a timing discriminator, a high-precision time-interval digitizer, and a signal-processing system. The time-resolution capabilities of the receiver are determined by the photoelectron time spread of the photoelectric device, the time walk and resolution characteristics of the timing discriminator, and the time-interval digitizer. It is thus necessary to evaluate available fast photoelectronic devices with respect to their time-resolution capabilities, and to design a very low time walk timing discriminator and a high-precision time digitizer which will be used in the laser ranging system receiver. (auth)

3120 (SAND-75-0116) SIMPLIFIED CALIBRATION SEQUENCE FOR SINGLE-ATOM MASS SPECTROMETERS. Panitz, J. A. (Sandia Labs., Albuquerque, N. Mex. (USA)). Oct 1975. Contract AT(29-1)-789. 16p. Dep. NTIS $4.00.

A calibration procedure is described for single-atom, time-of-flight mass spectrometers which essentially applies a least-squares analysis to the measured parameters of voltage, distance and time in order to calculate the actual potential at the specimen surface, and any time delay associated with the measurements. A computer program numerically solves the required simultaneous equations by a variation of the Newton-Raphson method, quickly predicting the unknown desorption pulse amplitude and time delay to an accuracy of one part in 10^5. (auth)

3121 (UCID-16937(Pt.1)) AUTOMATIC RADIOCHEMICAL GAS-SEPARATION SYSTEM DEVELOPMENT. Part I. Overview. Adams, T. M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 Oct 1975. Contract W-7405-Eng-48. 12p. Dep. NTIS $4.00.

A working prototype of a fully automatic gas-separation system has been constructed and is now operational in a semiautomatic mode under manual control. In its final form the system is designed to automatically select a sample of appropriate size, perform the desired separations and pertinent calculations, present real-time analytical results, and recover the purified sample constituents. The separations are accomplished by elution chromatography with a computer that controls, commands, and performs analytical calculations. Two laboratory innovations, fully temperature-programmable automatic elution columns and vacuum-actuated pneumatic valves, form the heart of the system. The configuration, design, operating procedure, and status of the system are described. A companion paper, Part 2, contains a detailed description of the individual system components. (auth)

3122 FLOW RATE METERS OF AREA TYPE FOR VERY LOW PRESSURE GAS. Mori, Yasuo (Tokyo Inst. of Tech. (Japan)); Ochiai, H. Nippon Kikai Gakkai Rombunshu; 40: No. 339, 3129-3138(Nov 1974). (In Japanese)

Relating to the uranium gas separation with super-centrifuges, the flow meters to measure the flow rate of very low pressure gas around 1 Torr are needed. The horizontal cylinder, area type flow meters for this purpose have been devised, and theoretically and experimentally investigated, which have the linear relation between indication and flow rate. In the flow meter for low flow rate range that has a force-receiving cylinder, experimental values agreed well with theoretical values, if the ratio of slip factor ζ to mean free path λ was assumed as $\zeta/\lambda = 0.9$, when the slip of gas at wall surface was taken into consideration. In the flow meter for high flow rate range that has a force-receiving disc of small pressure loss, flow rate Q is proportional to the square root of the fluid force F imposed on the disc. If the electric current I proportional to F was fed through a coil, and the electromagnetic force due to the current I was imposed on the disc, the relation between flow rate and the current became linear over a wide range. (JA)

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

Isotope Separation (Industrial)

Refer also to abstracts 2626 and 3122.

3123 (CONF-750324-7) URANIUM ENRICHMENT IN THE UNITED STATES. Hill, J. H.; Parks, J. W. (Energy Research and Development Administration, Oak Ridge, Tenn. (USA). Oak Ridge Operations Office). 1975. 22p. Dep. NTIS $4.50.

From international conference on uranium isotope separation; London, UK (5 Mar 1975).

History, improvement programs, status of electrical power availability, demands for uranium enrichment, operating plan for the U. S. enriching facilities, working inventory of enriched uranium, possible factors affecting deviations in the operating plan, status of gaseous diffusion technology, status of U. S. gas centrifuge advances, transfer of enrichment technology, gaseous diffusion–gas centrifuge comparison, new enrichment capacity, U. S. separative work pricing, and investment in nuclear energy are discussed. (LK)

3124 (CONF-750735-) URANIUM ENRICHMENT CONFERENCE ON MODIFIED CONTRACT OPTION, OAK RIDGE, TENNESSEE, JULY 22, 1975. (Energy Research and Development Administration, Oak Ridge, Tenn. (USA). Technical Information Center). 1975. 50p. Dep. NTIS $4.00.

From uranium enrichment conference on modified contract option; Oak Ridge, Tennessee, USA (22 Jul 1975).

The questions and answers presented in this document originated at an industry-wide meeting sponsored by the Energy Research and Development Administration held in Oak Ridge, Tennessee, on July 22, 1975, to discuss features and provisions of an ERDA plan to adjust contracts held by firms receiving uranium enriching services from ERDA. On June 19, 1975, ERDA announced terms of an expanded contract modification plan. The modified contract option broadened a previous plan proposed on January 15, 1975, by the former Atomic Energy Commission. The meeting in Oak Ridge on July 22, 1975, was designed to provide additional information on the expanded contract option and to offer ample opportunity for questions and answers prior to August 18, 1975, by which time enriching services customers who chose the one-time option had to so notify ERDA. The meeting included presentations by officials of ERDA Headquarters and ERDA's Oak Ridge Operations on the features of the contract adjustment offer, including provisions for contract termination in whole, separative work schedule adjustments, and uranium feed delivery schedule relaxation. (auth)

3125 (K-GD-1330) ENVIRONMENTAL ASPECTS OF COOLING TOWER OPERATION. Jallouk, P. A.; Kidd, G. J.; Shapiro, T.; Taylor, F. G. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Nuclear Div.). 1973. 26p. (CONF-750967-7). Dep. NTIS $4.50.

From third ERDA environmental protection conference; Chicago, Illinois, USA (23 Sep 1975).

A description is given of studies to determine the amounts and distribution of chromium and zinc discharged to the environment as a result of cooling tower operation at the Oak Ridge Gaseous Diffusion Plant. (DG)

3126 (UCRL-Trans-10919) EFFICIENCY OF SELECTIVE TWO-STEP LASER ACTION IN AN ATOMIC BEAM. Karlov, N. V.; Prokhorov, A. M. Translated from Kvantovaya Elektron. (Moscow); 2: No. 5, 1071-1074(1975). 7p. Dep. NTIS $4.50.

Formulas are given which make it possible to analyze the efficiency of selective two-step laser action in an atomic (molecular) beam as a function of such parameters as the intensity of selective and nonselective radiation, lifetime of the excited state and absorption cross section, and velocity of the beam and its extent. (LK)

3127 PHOTOPREDISSOCIATION ISOTOPE SEPARATION. Moore, C. B.; Sze-Shing Yeung, Edward. (to University of Southern California, Los Angeles (USA)). French Patent 2,215,263/A/. 24 Jan 1974. 18p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 26 Jan 1973, USA.

A source of monochromatic light excites individual isotopic rays of a good resolution absorption spectrum of a chemical compound placed in a dissociation chamber, the higher state being dissociated. Isotopic enrichment is thus achieved for the dissociation products which can be stable molecules or they can be trapped chemically as they are reactive. With this procedure the isotopic separation of hydrogen and deuterium can be achieved by exciting formaldehyde with a double frequency ruby laser. (tr-auth)

3128 STRAIN, VIBRATION FREQUENCIES AND ACCELERATION MEASUREMENTS IN CORROSIVE ATMOSPHERE. Chirac, J. L.; Emptas, P. (CEA Centre de Pierrelatte, 26 (France)); Cadoux, J. (Societe Metravib, 69 - Lyon (France)). Bull. Inf. Sci. Tech. (Paris); No. 201, 47-53(Mar 1975). (In French).

The use of accelerometers and strain gauges in gaseous UF_6 and connection of the system with a computer that analyzes in real time the form of 63 frequencies spectra of vibrations are described. (FR)

3129 LASER STIMULATED CHEMICAL REACTIONS AND ISOTOPE SEPARATION. Basov, N.G.; Belenov, E.M.; Isakov, V.A.; Markin, E.P.; Oraevskii, A.N.; Romanenko, V.I.; Ferapontov, N.B. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). Sov. J. Quantum Electron. 5: No. 5, 510-514 (May 1975).

A theoretical analysis is made of an isotope separation method based on chemical reactions stimulated by infrared laser radiation. It is shown that the anharmonicity of the molecular vibrations has practically no effect on the isotope separation coefficient. A description is given of an experiment in which the nitrogen isotopes were separated by the laser-stimulated reaction $N_2+O_2 \rightarrow 2NO$. This reaction was stimulated in a cell containing air which was subjected simultaneously to ruby laser radiation and to a strong Stokes component generated separately by stimulated Raman scattering in liquid nitrogen. (auth)

3130 EFFICIENCY OF SELECTIVE TWO-STAGE LASER INTERACTION WITH AN ATOMIC BEAM. Karlov, N.V.; Prokhorov, A.M. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). Sov. J. Quantum Electron. 5: No. 5, 585-587 (May 1975).

The efficiency of a two-stage selective laser interaction with an atomic beam is analyzed on the assumption that the interaction region is uniformly illuminated and the atomic beam is an optically thin layer. It is assumed that there is no spontaneous or field-induced recombination. The analysis is made for three energy levels. Formulas are obtained for the dependences of the efficiency of the interaction on such parameters as the laser radiation intensity, excited-state lifetime, absorption cross section, atomic (molecular) beam velocity, and dimensions of this beam. (auth)

3131 PROCESS FOR THE CENTRIFUGAL SEPARATION OF A MIXTURE AND APPARATUS FOR THE SAME. Tamai, K.; Tsuno, H.; Hashimoto, O.; Iwai, T.; Shionoya, K. (to Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Japanese Patent 1974-5859/B/. 10 Apr 1969. 11p. (In Japanese)

Conventional centrifugal separators have a single hollow rotary drum rotably supported within a stationary housing. In centrifuges of this type, efficiency is limited by the mechanical strength of the rotary member which is driven at an extremely high peripheral velocity and, moreover, since the effect of centrifugal force along the core is small, performance at the core is poor. The present invention discloses a centrifuge comprising at least two concentric rotary drums supported within a housing, with the inner drum rotatable at a higher frequency than the outer drum. A mixture supplied by suitable means to the gap defined by the inner and outer drum is acted upon by centrifugal forces simultaneously produced by the rotation thereof. Means are provided either to completely withdraw both of the thus separated light and heavy components or to transfer the mixture onto successive stages for further separation in cases where three or more rotary drums are employed. (JA)

3132 GAS CENTRIFUGE. Tawara, H.; Sakurai, M. (to Tokyo Shibaura Electric Co. Ltd. Kawasaki, Kanagawa (Japan)). Japanese Patent 1974-13552/B/. 20 Mar 1970. 3p. (In Japanese)

The present invention relates to an apparatus which is used to centrifugally separate high mass number gases from low mass number gases. Four rotating cylinders are mounted in series on one rotating axle driven by an electric motor. The gas mixture is introduced through a coaxially provided tube into the center of each cylinder. Convection currents are produced in each cylinder by means of heat sources and heat sinks alternately disposed between cylinders and centrifugally separated gases are exhausted from orifices circumferentially disposed at the top and bottom plates of each cylinder, with the thus separated components withdrawn with a carrier gas. Since the rotating cylinders are disposed in series on the axle and are driven by a single motor, the number of bearings and drive motors is reduced significantly

allowing a large power consumption reduction. Since a symmetrical temperature distribution results from the alternately disposed nature of the heat sources and the heat sinks, gas-seals between cylinders may be omitted due to the fact that the gases exhausted from orifices facing each other have the same composition. (JA)

3133 DAMPING APPARATUS FOR A CENTRIFUGE. Nagai, T. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1974-33390/B/. 30 Nov 1970. 3p. (In Japanese)

In a centrifuge having a rotary drum rotatably mounted within a vacuum tank, a damping device is disclosed for supporting the rotary shaft of the rotary drum while damping the vibrations thereof. The device consists principally of a mounting frame formed within the vacuum tank and a retaining member fixed thereto via a gum damper bracket for retaining an oil-less bearing arranged such that a clearance is defined between it and the rotary shaft protruding therethrough. The thus constructed damping device makes contact with the rotary shaft only at critical speeds to prevent vibration while a non-contact supporting condition exists at all other rotating speeds, thereby reducing power losses and damage due to friction, and enabling forced lubrication bearings and their oil sealing devices to be eliminated. (JA)

3134 BASIC CHARACTERISTICS OF A LOW URANIUM ENRICHMENT CASCADE BY CENTRIFUGATION, (1). Kai, Tsunetoshi (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Nippon Genshiryoku Gakkaishi; 17: No. 1, 31-44 (Jan 1975). (In Japanese)

With a view to ensuring more logical application to the cascade theory of centrfuges, the separative factor $N'(1-N)/N(1-N')$, currently adopted in such studies, is replaced by a "separative coefficient", defined by $\alpha = N'/N$ (N being the mole fraction of ^{235}U). Using this coefficient, equations expressing the distributions of flow and of isotope concentration are obtained from the material balance relations. Several other equations, applicable to the ideal cascade, giving the separative power and expressing the value function are also derived. These equations are then utilized in the consideration of control problems, such as the influence of loss and cut, and the treatment of reflux and of product withdrawal from stages other than the top. Simulation of an actual cascade for uranium isotope separation by centrifugation is undertaken with use made of the Monte Carlo method, assuming that losses, cuts, separative coefficients and the feed flow are normally distributed with certain mean values and variances. The mean values of the separative coefficients are assumed to satisfy the equations for a single centrifuge (separative coefficients being functions of flow). The analysis proves that provided the separating units work as prescibed by theory, operation of the centrifuge cascade should not be difficult, since no necessity is indicated for strict control, while at the same time product concentration could be adjusted to a certain extent, and moreover the cascade would not be sensitively affected by losses. (auth)

3135 BASIC CHARACTERISTICS OF CENTRIFUGES, (1). Analysis of Concentration Distribution in Centrifuges. Kai, Tsunetoshi (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Nippon Genshiryoku Gakkaishi; 17: No. 3, 131-140(Mar 1974). (In Japanese)

In order to analyze gas centrifuge performance, it is essential to know the concentration distribution. In the present paper the basic equation for centrifugal separation is derived from Hirschfelder's expression for binary diffusion. This two-dimensional partial differential equation can be solved very accurately by numerical computation. The velocity profile of the flows being likened to a step function, the concentration distribution and separative performance can be calculated for various types of centrifuges. This permits determination of the relation holding between such factors as cut, feed flow rate, feed point and reflux rate. Furthermore, comparisons are made between concurrent and countercurrent flows, and a discussion is presented on the characteristics of various countercurrent flows - those embodying circulation, as well as devoid of circulation and of reflux. These results should prove very useful for basic designs of centrifuges. (auth)

Isotopic Power Sources

3136 (FSEC-NSG-217-75/50) NUCLEAR HEAT SOURCES FOR CRYOGENIC REFRIGERATOR APPLICATIONS. Raab, B.; Schock, A.; King, W. G.; Kline, T.; Russo, F. A. (Fairchild Space and Electronics Co., Germantown, Md. (USA)). 6 Jun 1975. Contract AT(49-15)-3063. 73p. (ERDA-SNS-3063-7). Dep. NTIS $6.75.

Spacecraft cryogenic refrigerators require thermal inputs on the order of 1000 W. First, the characteristics of solar-electric and radioisotope heat source systems for supplying this thermal input are compared. Then the design of a ^{238}Pu heat source for this application is described, and equipment for shipping and handling the heat source is discussed. (LCL)

3137 (LA-UR-75-2037) INTERACTION OF $^{238}PuO_2$ HEAT SOURCES WITH TERRESTRIAL AND AQUATIC ENVIRONMENTS. Patterson, J. H.; Nelson, G. B.; Matlack, G. M.; Waterbury, G. R. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-ENG-36. 28p. (CONF-751105-8; SM-199/100). Dep. NTIS $5.00.

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, California, USA (17 Nov 1975).

Radioisotope thermoelectric generators used in space missions are designed with a great factor of safety to ensure that they will withstand reentry from orbit and impact with the earth, and safely contain the nuclear fuel until it is recovered. Existing designs, utilizing $^{238}PuO_2$ fuel, have proved more than adequately safe. More data about the interaction of this material with terrestrial and aquatic environments is continually being sought to predict the behavior of these heat sources in the extremely unlikely contact of these materials with the land or ocean. Terrestrial environments are simulated with large environmental chambers that permit control of temperature, humidity, and rainfall using different kinds of soils. Rain falling on thermally hot chunks of $^{238}PuO_2$ causes the spallation of the surface of the fuel into extremely fine particles, as small as 50 nm, that are later transported downward through the soil. Some of the plutonia particles become agglomerated with soil particles. Plutonium transport is more significant during winter than during summer because evaporation losses from the soil are less in winter. Aquatic environments are simulated with large aquaria that provide temperature and aeration control. Earlier fuel designs that employed a plutonia-molybdenum cermet showed plutonium release rates of about 10 mu Ci/m^2 - s, referred to the total surface area of the cermet. Present advanced fuels, employing pure plutonium oxide, show release rates of about 20 nCi/m^2 - s in seawater and about 150 nCi/m^2 - s in freshwater. The temperature of these more advanced heat sources does not seem to affect the release rate in seawater. (auth)

Radiation Sources

Refer also to abstract 3201.

3138 (BNL-20437) MULTILAYER MONOCHROMATORS FOR NEUTRON SCATTERING. Saxena, A. M.; Schoenborn, B. P. (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. 38p. (CONF-750629-5). Dep. NTIS $5.00.

From symposium on neutron scattering for the analysis of biological structures; Upton, New York, USA (2 Jun 1975).

In an earlier paper Schoenborn, Caspar, and Kammerer (J. Appl. Cryst. 7, 508-10(1974)) reported the fabrication of thin film monochromators for neutrons. They showed that a multilayer consisting of alternating films of two materials acts as a good monochromator with large and adjustable periodicity and wide bandwidth. The diffraction properties of these multilayers have been studied with the objective of using them as monochromators, filters and polarizers for neutrons. A theoretical understanding of these multilayers has been developed by using the kinematical and dynamical approaches. In order to compare these expressions with the observed properties, the effects of beam divergence and wavelength distribution for the spectrometer have been determined. The influence of some aperiodicity on the diffraction data has also been studied within the framework of kinematical theory. (auth)

3139 (PTB-FMRB-61) MECHANICAL VELOCITY SELECTOR FOR NEUTRONS WITH A WAVE LENGTH GREATER THAN 0.4 nm. Tieben, H.; Wendt, W. (Physikalisch-Technische Bundesanstalt, Braunschweig (F. R. Germany). Forschungs-und Messreaktor). Jul 1975. 35p. (In German) Dep. NTIS (US Sales Only) $5.00.

A mechanical velocity selector with twisted acrylic glass plates glued to the rotor is described. The selector is designed for use in the neutron wavelength region above 0.4 nanometers. The transmission is 62% and the full width at half maximum of the triangular spectrum of the transmitted neutrons with the wavelength λ_0 is $\pm$ 0.06 λ_0. The rotor runs in the vacuum; it is magnetically coupled to the drive motor, its speed is stabilized to maximum deviations of 0.03%. The application of the selector in studies of bloch walls is described. (auth)

3140 (REG/G-6.7(10.75)) PREPARATION OF AN ENVIRONMENTAL REPORT TO SUPPORT A RULE MAKING PETITION SEEKING AN EXEMPTION FOR A RADIONUCLIDE-CONTAINING PRODUCT. (Nuclear Regulatory Commission, Washington, D. C.

(USA). Office of Standards Development). Oct 1975. 12p. NUREG.

Design and Fabrication

Refer also to abstract 3112.

3141 (DP-MS-75-9) EQUIPMENT AND OPERATIONS FOR PREPARING ^{252}Cf NEUTRON SOURCES FOR INTERSTITIAL CANCER RADIOTHERAPY RESEARCH. Walker, V. W. (DuPont de Nemours (E. I.) and Co., Aiken, S. C. (USA). Savannah River Plant). 1975. Contract AT(07-2)-1. 22p. (CONF-751101-21). Dep. NTIS $4.25.

From joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

The Savannah River Laboratory (SRL) is currently producing californium-252 sources for a medical evaluation program in neutron radiotherapy. These sources provide an intense, tiny, neutron point source for cancer therapy research. Instead of using a large beam of neutrons from a reactor or accelerator for tumor treatments, the implantable ^{252}Cf neutron source delivers a highly localized radiation dose within the tumor itself. The equipment design and operations for producing the sources, the Pt-Ir clad wire containing the Pd-Cf_2O_3 cermet core, and the assembly of 3 to 12 seeds sealed within a radiation resistant 1.20 mm plastic tube are described. All operations are performed by machines specially designed for remote operation in a shielded cell. (auth)

3142 (DP-MS-75-103) FABRICATION OF INTENSE NEUTRON SOURCES FOR MEDICAL APPLICATIONS. Boulogne, A. R.; Walker, V. W. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. (USA). Savannah River Lab.). 1975. Contract AT(07-2)-1. 18p. (CONF-751114-3). Dep. NTIS $4.50.

From californium-252 utilization meeting; San Diego, California, USA (4 Nov 1975).

Simulated sources containing ^{252}Cf equivalents of 0.1 to 1.0 milligrams were prepared. Samarium was used as the simulant in a modified chemical plating technique similar to that used to prepare palladium-californium oxide cermet for industrial applications. The length of the platinum-10 percent iridium doubly encapsulated source with its protective sheath is 0.545 in. (14.1 mm). Outside dia of the source, including its sheath, is 0.109 in. (2.8 mm). Existing "Brachytrons" can accommodate this source form. This capsule system will withstand internal gas pressures from helium due to alpha decay and fission gases from a 1 mg ^{252}Cf source after ten years if the source is subjected to a maximum temperature of 800°C, the theoretical temperature of an accidental fire. Under these conditions the safety factor is 3. The capsule system is being tested with tracer amounts of ^{252}Cf to ensure that it will withstand adverse service conditions as well as tests specified for Special Form Materials. (auth)

3143 (INIS-mf-1698, pp 257-263) DESCRIPTION OF EXPERIMENTAL FACILITY FOR STUDYING NEUTRON TOTAL CROSS SECTIONS IN THE ENERGY RANGE FROM 10^{-1} UP TO 10^{-7} eV. Stepanov, S. B.; Zhitarev, V. E.; Zelenyuk, F. M.; Timakov, A. V. 1974. (In Russian)

From 2nd all-union conference on neutron physics; Obninsk, USSR (3 Mar 1974).

In neutron physics. Part 4. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.).

An experimental complex is described on investigating total neutron reaction cross-sections with the use of three methods of obtaining monochromatic neutron beams. In all three cases the beams from a reactor are filtered by means of curved neutron guides. In the energy region of 10^{-1} to 1.3×10^{-3} eV a time-of-flight technique is used. In the range of 1.3×10^{-3} to 2×10^{-4} eV the monochromatization is accomplished by a single crystal of the synthetic mica fluorphlogopite. In order to obtain monochromatic beams in the energy range of 2×10^{-4} to 10^{-7} eV a monochromator with movable single crystals of fluorphlogopite was developed. The velocity of the single crystal is 200 m/sec. Neutrons of energy 8.6×10^{-4} eV are converted to monochromatic beams with energies from 10^{-4} eV to 10^{-7} eV. (tr-SJR)

Industrial Uses

Refer also to abstract 3183.

3144 SAFETY OF RADIOACTIVE SEALED SOURCES FOR INDUSTRIAL USES. Chatelet, J.; Touzin, R. (Conservatoire National des Arts et Metiers (CNAM), 75 - Paris (France). Lab. National d'Essais). pp 157-164 of 8. National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French).

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

The principles governing the safety of radioactive sealed sources used in industry are specified especially as to their containment, radiation protection of the environment and safe operation of the devices. (FR)

3145 RADIOCHEMICAL METHOD FOR DETERMINING TREADWEAR. Patel, A. C. (to Ashland Oil, Inc.). US Patent 3,905,221. 16 Sep 1975. Filed Date 21 May 1973. 10p.

A method for determining amount of treadwear of a tire is disclosed. The tire tread surface is impregnated with a radioactive material (iodine dissolved in toluene) and initial radioactivity measured at the tread surface. Subsequent measurements of radioactivity after wearing away tread indicate the amount of tread loss, when such measurements are compared with a calibration curve of radioactivity prepared for rubber of same composition and radioactive material of same concentration. Calibration curves are made by mechanically measuring loss of tread thickness of radioactive-impregnated rubber samples and measuring corresponding radioactivity remaining. (auth)

3146 FOOD IRRADIATION ESTABLISHMENT. Hokkaido Shihoro Isotope Irradiation Center. Tanaka, Y.; Takemura, M. (Kawasaki Heavy Industries, Ltd., Kobe (Japan). Technical Research Lab.); Nishiyama, A.; Shimizu, N.; Takada, S. FAPIG (Tokyo); No. 74, 35-41(Sep 1974). (In Japanese)

A food irradiation plant of which the practical scale is the biggest in the world was established by Hokkaido Shihoro Nokyo, the main subject of undertaking, and began to operate on a full scale from January 11, 1974. Irradiation to potatoes of 15,000 t was finished in March. This plant is epoc-making in using an usual potato transport container (1.7m x 1.1m x 1.3m) as a container for irradiation just as it is. This plant has ^{60}Co irradiation source of three hundred thousand curie and is able to deal with potatoes of ten thousand t per month. Characteristics in planning of this irradiation establishment and problems in buildings are described. At the same time, it is declared that this plan and construction becomes the starting point for establishment of irradiation establishment of commerical scale and irradiation system as a production means in large scale. (JA)

3147 CURRENT STATE OF THE UTILIZATION OF RADIOISOTOPES IN HUNGARY. Foeldiak, G. (Hungarian Academy of Sciences (Hungary). Inst. of Isotopes). Proc. Jpn. Conf. Radioisotop.; No. 11, 58-67(Aug 1974).

From 11th Japan conference on radioisotopes; Tokyo, Japan (13 Nov 1973).

The general feature of the application of isotopes in Hungary is that the personal and technical bases have been laid down and the isotopic methods have found their place in industry and sciences. These applications have reached an acceptable level but there is still much to do both in enlarging their volume and bringing them more up-to-date. (auth)

3148 THE PRESENT STATUS ON THE USE OF ^{85}Kr. Kasamatsu, T. (Japan Atomic Energy Research Inst., Takasaki, Gunma. Takasaki Radiation Chemistry Research Establishment). Genshiryoku Kogyo; 20: No. 11, 23-28(Nov 1974). (In Japanese)

The attractive features of Kr are that it is inert, it is in the gaseous state in its normal condition, that it permeates easily through very thin substances, and that it is apt to leak through a minute gap. Through Kr is available only in the form of mixtures of many isotopes at present, it may be considered as a β source of 0.67 MeV. Presently, the main use of ^{85}Kr is as sealed source for thickness gauges, level gauges, and moisture gauges. However, ^{85}Kr gas is employed for leak testing of vacuum tubes. ^{85}Kr utilization in large quantities includes its use as an irradiation source for curing of coatings. Applications of ^{85}Kr to the chemical reaction of liquids and to solids irradiation by injecting ^{85}Kr gas into a sealed tank in which a solid is placed are described. (JA)

3149 METHOD OF IRRADIATING LUMBER AND OTHER SOLID BODIES. Sakuta, M.; Yamamoto, M. (to Taisei Construction Co. Ltd., Tokyo (Japan)). Japanese Patent 1974-4120/B/. 26 Nov 1969. 2p. (In Japanese)

An irradiation method is disclosed in which objects to be irradiated are transported via a conveyor system through a water tank filled with floating layers of spherical irradiating bodies. The irradiating bodies are approximately 10-20 cm in diameter and consist of a centrally locked γ source enclosed within a radiation permeable material having a low specific gravity such as foamed concrete which is surrounded by a stainless steel shell

or the like. The objects to undergo irradiation are transported from an inlet channel through the irradiating tank where they are brought into direct contact with the spherical irradiating bodies before being discharged into a post-treatment storage pool. No large-scale irradiation equipment is required, and close contact with the irradiating spheres assures effective treatment. The method may be employed to sterilize lumber or destroy parasite infested material. (JA)

LIFE SCIENCES

3150 TECHNICAL SHEETS OF IONIZING RADIATIONS. 2. Non-Ionizing Radiations. Rayonnem. Ionis. Tech. Mes. Prot.; No. 1, 25-28(Jan 1975). (In French).

The biological effects of different non-ionizing radiations are studied: ultra-violet radiation, visible radiation, infrared radiation, micrometric waves, ultrasonics. In spite of their apparent diversity these radiations are similar in their physico-chemical effects, but in view of their widely varying production methods and types of application each type is considered separately. It is pointed out that no organization resembling the CIPR exists in the field of non-ionizing radiations, the result being a great disparity amongst the different legislations in force. (FR)

3151 TUNNEL EFFECT IN EXCITED AND IONIZED STATES OF NUCLEIC ACID BASES AND SOME ASPECTS OF RADIATION-INDUCED POINT GENE MUTATIONS. Pleticha-Lansky, R. (Inst. of Experimental Botany, Prague). Radiochem. Radioanal. Lett.; 22: No. 5, 341-350(24 Sep 1975).

Radiation-induced perturbations of the genetic code are discussed from the standpoint of the frequency and specificity of mutations. According to Löwdin's theory of tautomeric rearrangement of nucleic acid base pairs through the tunnel effect, it is probable, that the proton potential in hydrogen bridges can be also affected by the incorporation of some radiolytic products of purines and pyrimidines into DNA as mistake bases. In this way it is possible to eliminate any exo- or endogeneous energetic irradiation of the biological material and so to eliminate various undesirable damages of DNA. Thus higher specificity in the controlling of the genetic code changes would result. (auth)

Radiation Effects on Biochemicals

Refer also to abstract 2957.

3152 (AECD/MISC-4, pp 115-117) STUDIES ON THE ENZYMOLOGICAL ASPECTS OF EGG (POULTRY IRRADIATION). Sarwar-E-Alam, M.; Amin, M. R. (Atomic Energy Center, Dacca, Bangladesh). Dec 1974.

In annual technical report, July 1972-June 1973. (Atomic Energy Center, Dacca (Bangladesh)).

3153 CONFORMATION AND FUNCTIONING OF tRNAs: CROSS-LINKED tRNAs AS SUBSTRATE FOR tRNA NUCLEOTIDYL-TRANSFERASE AND AMINOACYL SYNTHETASES. Carre, D. S. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Biochimie); Thomas, G.; Favre, A. (Paris-7 Univ., 75 (France). Inst. de Biologie Moleculaire). Biochimie (Paris); 56: No. 8, 1089-1101(1974).

The behavior of mixed E. coli tRNAs cross-linked by irradiation with near ultraviolet light (310 to 400 nm) has been compared to that of the intact molecules in two enzymatic processes. No change in the rate and extent of the repair of the pCpCpA 3′ terminus of tRNA by purified E. coli tRNA nucleotidyltransferase can be detected. In contrast, complex data were obtained in the acylation reaction. They can be understood using other tRNA specific modifications as well as our present knowledge of E. coli tRNA sequences and rare base content. (FR)

3154 THE EFFECT OF MOISTURE CONTENTS ON THE FORMATION OF RADICALS AND THE PHYSICOCHEMICAL PROPERTIES IN RICE STARCH BY γ-RAY IRRADIATION. Komiya, T.; Nara, S. (Mie Univ., Tsu (Japan). Faculty of Agriculture). Nippon Shokuhin Kogyo Gakkaishi; 22: No. 1, 24-29(Jan 1975). (In Japanese)

The effect of radiation with a dose of 0.5 Mrad on rice starch as a function of its water content has been investigated by particularly studying the changes of formed radicals by ESR and physicochemical properties. In case of 10 Krad irradiated starch in 1 to 8% (dry basis) moisture, the signal of radicals was a singlet, but at 30 Krad in 15 to 30% moisture, the signal showed a complex pattern. Their radical contents decreased by the increase of moisture content. At to 8% moisture contents level, radicals formed considerably larger than that of 15 to 30%. It was found that the water molecule was considered to have a role of protective effect. Thus, the similar tendency was observed in the cases of intrinsic viscosity, mean degree of polymerization, iodine affinity, and content of carboxyl group. As to stability of radicals, the radicals in 1 to 5% moisture contents were kept considerably stable for 24 hours. But, the radicals in higher moisture contents were unstable and the radical contents decreased more rapidly with the increase of moisture content. In more than 11% moisture contents, the radical contents decreased rapidly just after exposure to air. (auth)

3155 γ-IRRADIATION EFFECTS ON THE ANTIOXIDATIVE ACTIVITY DEVELOPING IN THE AMINO ACID-SUGAR REACTION. Fujimaki, M.; Morita, M.; Kashio, H.; Kato, H. (Tokyo Univ. (Japan). Faculty of Agriculture). Agric. Biol. Chem. (Tokyo); 38: No. 12, 2323-2327(Dec 1974).

The effects of γ irradiation on the antioxidative activity developing in the amino acid-sugar reaction were investigated. The antioxidative activity of the nondialyzable melanoidin prepared from glycine and D-glucose was not much affected by γ irradiation. However, the development of the antioxidative activity of an L-leucine-D-glucose solution on heating was markedly accelerated when the mixture had been preirradiated with γ rays, and the development of the activity was more prominent than that of the brown color. The irradiation of a glucose solution alone accelerated the antioxidative activity development when heated with leucine, but the irradiation of a leucine solution alone did not cause a similar effect when heated with glucose. Except an L-cysteine-glucose combination, all combinations of amino acids and sugars tested gave rise to almost similar antioxidative effects. (auth)

3156 REPAIR OF RADIATION DAMAGES IN BACTERIOPHAGE DNA. Ogawa, H. (Osaka Univ., Toyonaka (Japan). Faculty of Science). Tanpakushitsu Kakusan Koso; 19: No. 8, 583-596(Aug 1974). (In Japanese)

Discussion was made on the way and the time of genes reproduction in repair of radiation damages in bacteriophage DNA of Escherichia coli by using x ray. Bacteriophage DNA was given rise to damages by ultraviolet irradiation and was inactivated. Then two or more of inactivated phages were infected (multiplicity) and reactivation was induced. This mechanism was discussed and consideration was made as to phage production capacity and proliferation speed after irradiation on the basis of Lauria-Latarjet's experiment. On the other hand, repair of host bacteria was discussed in T strain phage and λ phage. Small amount of ultraviolet was further irradiated to bacteria which infected λ phage inactivated by ultraviolet irradiation, and λ phage induced reactivation. This ultraviolet repair was discussed from relationship to recombination and that to recovery of host bacteria. Furthermore, repair of phage DNA damage by ionizing radiation and break and repair of DNA chain by decomposition of ^{32}P atom taken into DNA were considered. (JA)

3157 DNA REPAIR AND GENETIC RECOMBINATION IN BACILLUS SUBTILIS. Shibata, T. (Institute of Physical and Chemical Research, Wako, Saitama (Japan)); Saito, H. Tanpakushitsu Kakusan Koso; 19: No. 8, 597-609(Aug 1974). (In Japanese)

Information on DNA repair and genetic recombination in Bacillus subtilis was in order. DNA repair to ultraviolet ray injuries of trophocytes was compared with DNA repair of Escherichia coli and they were discussed. Variation of genetic recombination was discussed from a view-point of DNA repair. Ultraviolet ray injuries in spores and their repair and genetic recombination mechanism in plasma cell of Bacillus subtilis were also discussed. (JA)

3158 RELATIVE FREQUENCY OF FORMATION OF BASE RADIOPRODUCT, SINGLE AND DOUBLE STRAND BREAKS ON γ-IRRADIATION OF DILUTED AQUEOUS SOLUTION OF DNA. Ryznar, L.; Drasil, V. (Inst. of Biophysics, Brno). Radiochem. Radioanal. Lett.; 22: No. 5, 351-355(24 Sep 1975).

Diluted aqueous solution of DNA labelled with 6-^{3}H-TdR was irradiated in the absence of oxygen and numbers of formed single and double strand breaks and the 5, 6-dihydrothymine (DHT) yield were determined. The results indicate that, under given conditions, a molecule of a base radioproduct is formed approximately 10 times more frequently than one single strand break. The occurrence of a single strand break is 20 times higher than that of a double strand break. (auth)

3159 SERA FROM IRRADIATED RABBITS AS A SOURCE OF COMPLEMENT FOR IMMUNE CYTOLYSIS ASSAYS. Walker, W. S. (St Jude Children's Research Hospital, Memphis); Mills, B.; Mohanakumar, T. Transplantation; 20: No. 3, 260-262(Sep 1975).

A procedure is described for obtaining sera from gamma-irradiated rabbits with reduced toxicity to human leukemia cells but with sufficient complement activity to be useful in immune

cytolysis assays. It is emphasized that although irradiation reduces the cytotoxic activity present in normal rabbit serum, the amount of reduction depends both on the time following exposure to radiation and on the population of test cells. Results indicate that irradiation increases the proportion of rabbits yielding acceptable serum for immune cytolysis assays. (HLW)

3160 EVIDENCE FOR PHOTOINDUCED CROSS-LINKAGE, IN SITU, OF 30S RIBOSOMAL PROTEINS TO 16S rRNA. Gorelic, L. (Wayne State Univ., Detroit). Biochemistry; 14: No. 21, 4627-4633(21 Oct 1975).

The effects of ultraviolet radiation on the 30S ribosomal subunit of Escherichia coli were studied. Irradiation in aqueous solution under anaerobic conditions resulted in a dose-dependent decrease in the separability of the rRNA and protein components of the 30S ribosomal sub-unit in 4 M urea-3 M LiCl. The results of gel filtration studies of the irradiated ribosomes before and after treatment with pancreatic ribonuclease indicated that the decrease in separability of the ribosome components was a result of the photoinduced formation of covalent RNA-protein cross-links. The number of covalent cross-links was estimated to correspond to less than 3 per 10,000 daltons of ribosomal proteins. One-dimensional gel electrophoresis studies of the course of the photoinduced cross-linkage reaction indicated that cross-linkage of individual 30S ribosomal proteins to the 16S rRNA proceeds in two dose-dependent steps. The first step requires an input of 1×10^{20} quanta of 253.7-nm radiation and results in the cross-linkage of at least five ribosomal proteins to the 16S rRNA. The second step requires a total input of 2×10^{20} quanta of 253.7-nm radiation, and results in the cross-linkage of most of the remaining 30S ribosomal proteins to the 16S rRNA. (auth)

3161 FLUORESCENCE AND BIOLUMINESCENCE OF BACTERIAL LUCIFERASE INTERMEDIATES. Balny, C.; Hastings, J. W. (Ecole des Hautes Etudes, Paris). Biochemistry; 14: No. 21, 4719-4723(21 Oct 1975).

An intermediate in the luciferase-catalyzed bioluminescent oxidation of $FMNH_2$, isolated and purified by chromatography at -20^0, was postulated to be an oxygenated reduced flavine-luciferase. Maintained and studied at -20 to -30^0, this material exhibits a relatively weak fluorescence emission peaking at about 505 nm when excited at 370 nm. It may comprise more than one species. Upon continued exposure to light at 370 nm, the intensity of this fluorescence increases, often by a factor of 5 or more, and its emission spectrum is blue shifted to a maximum at about 485 nm. Upon warming this fluorescence is lost and the fluorescence of flavine mononucleotide appears. If warming is carried out in the presence of a long chain aldehyde, bioluminescence occurs, with the appearance of a similar amount of flavine fluorescence. The bioluminescence yield is about the same with irradiated and nonirradiated samples. The bioluminescence emission spectrum corresponds exactly to the fluorescence emission spectrum of the intermediate formed by irradiation, implicating the latter as being structurally close to the emitting species in bioluminescence. (auth)

Radiation Effects on Cells

Refer also to abstract 3225.

3162 (EUR-5273d-e-f(Vol. 1), pp 71-91) MICRODOSIMETRIC DATA AND THE BIOLOGICAL EFFECTIVENESS OF NEUTRONS. Kellerer, A. M. (Columbia Univ., New York). Mar 1975.

From 2nd symposium on neutron dosimetry in biology and medicine; Neuherberg/Munich, F.R. Germany (30 Sep 1974).

In proceedings of second symposium on neutron dosimetry in biology and medicine. I.

Neutrons offer a convenient example of a radiation for which the microdosimetric analysis can be understood in close analogy to the more familiar LET concept. An attempt is made to survey neutron RBE as a function of dose in comparison with γ or x radiation. Data are reviewed on the RBE of neutrons, γ, and x radiation for mutation induction in Tradescantia, the survival of cultured hamster cells, and other cells that illustrate the distinction between the absorbed dose and the actual energy deposition in a microscopic region for microdosimetry. (CH)

Radiation Effects on Microorganisms

Refer also to abstracts 3146, 3153, 3156, 3157, 3188, 3190, and 3194.

3163 (AECD/MISC-4, pp 106-109) STUDIES ON THE IRRADIATION OF FRESH-WATER CARP (LABIO RUHITA) IN BANGLADESH (STARTED NOVEMBER 1972). Chowdhury, S. U.; Rahman, A. T. M. F.; Hossain, M. A.; Matin, M. A.; Choudhury, N.; Siddiqui, A. K.; Sarwar-E-Alam, M.; Amin, M. R.; Youssouf, Q. M. (Atomic Energy Center, Dacca, Bangladesh). Dec 1974.

In annual technical report, July 1972-June 1973. (Atomic Energy Center, Dacca (Bangladesh)).

3164 (AECD/MISC-4, pp 110-111) SPROUT INHIBITION AND ROT CONTROL OF POTATOES AND ONIONS BY RADIATION AND CHEMICAL TREATMENT. Rahman, A. T. M. F.; Siddiqui, A. K. (Atomic Energy Center, Dacca, Bangladesh). Dec 1974.

In annual technical report, July 1972-June 1973. (Atomic Energy Center, Dacca (Bangladesh)).

3165 (AECD/MISC-4, pp 111-114) PRESERVATION OF MANGO-JUICE BY IRRADIATION AND HEAT TREATMENT. Rahman, A. T. M. F.; Siddiqui, A. K. (Atomic Energy Centre, Dacca, Bangladesh). Dec 1974.

In annual technical report, July 1972-June 1973. (Atomic Energy Center, Dacca (Bangladesh)).

3166 (COO-3232-7) MOLECULAR BASIS FOR THE MUTAGENIC AND LETHAL EFFECTS OF ULTRAVIOLET IRRADIATION. Progress Report, September 1, 1975-August 31, 1976. Grossman, L.; McCollum, E. V. (Johns Hopkins Univ., Baltimore, Md. (USA)). 1975. Contract AT(11-1)-3232. 28p. Dep. NTIS $5.00.

Progress is reported on studies on the lethal and mutagenic effects of ultraviolet radiation in Escherichia coli. The role of enzymes and genes controlling the repair of DNA damage is discussed. (CH)

3167 (EUR-5273d-e-f(Vol.1), pp 389-396) U-120 CYCLOTRON AS A FAST NEUTRON SOURCE FOR IRRADIATIONS OF BIOLOGICAL OBJECTS. Wojciechowski, H.; Huczkowski, J.; Gacek, E.; Krasnowolski, S.; Szymusik, B.; Kasper, E. (Inst. of Nuclear Physics, Krakow). Mar 1975.

From 2nd symposium on neutron dosimetry in biology and medicine; Neuherberg/Munich, F.R. Germany (30 Sep 1974).

In proceedings of second symposium on neutron dosimetry in biology and medicine. I.

The paper describes the use of the U-120 cyclotron of the Institute of Nuclear Physics, Cracow, for irradiation of seeds and microorganisms by fast neutrons produced by bombarding a thick beryllium target by 12.5 MeV deuterons. The principle of the target holder construction and dosimetry is included. Some results concerning the radiosensitivity of seeds and microorganisms to fast neutron are given. (auth)

3168 (EUR-5273d-e-f(Vol.1), pp 581-591) BIOLOGICAL DOSIMETER; PARAMETER OF RBE-VALUES FOR 14.8 MeV NEUTRONS AND GAMMA RADIATION OF ^{60}Co. Luethy, H.; Roth, J. (Kantonsspital, Basel). Mar 1975. (In German)

From 2nd symposium on neutron dosimetry in biology and medicine; Neuherberg/Munich, F.R. Germany (30 Sep 1974).

In proceedings of second symposium on neutron dosimetry in biology and medicine. I.

The application of biological systems as dosimeters for neutrons and γ must meet certain requirements. These are extensively fullfilled in experiments for the inhibition of growth of Vicia faba seedlings and partially fullfilled for the inhibition of growth of two species of Phycomycetes. The effect of irradiation is measured by $(\bar{v}/\bar{v}_K) \rightarrow$ minimum instead of the index of growth in ten days. The temporal appearance of this effect depends on dose and dose-rate. The calculation of dose from measured neutron fluence takes into consideration the atomic composition of the seedlings. When equal dose rate is applied for the test and the reference radiation (^{60}Co), the RBE-values are independent of the effect. Correction-factors for the range of dose rates from 0.7 to 650 rd/min gamma radiation are included. (auth)

3169 (SAND-75-5640) THERMORADIATION TREATMENT OF SEWAGE SLUDGE TO ELIMINATE PATHOGENS FOR SAFE USE AS FERTILIZER AND ANIMAL FEED SUPPLEMENT. Sivinski, H. D.; Whitfield, W. J. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1975. 23p. (CONF-750967-12). Dep. NTIS $4.25.

From 3rd ERDA environmental protection conference; Chicago, Illinois, USA (23 Sep 1975).

This paper describes a research program titled "Waste Resources Utilization" using a new technique, called thermoradiation to destroy pathogenic organisms in sewage sludge. The thermoradiated sewage sludge will be used to study the feasibility of use for safe land application as fertilizer and soil conditioner and use as a feed supplement for ruminant animals. Experiments to date have shown good results for sludge disinfection of resistant

bacteria, viruses, and parasites. Thermoradiation experiments are being carried out at a temperature of 65°C combined with 160 krad gamma dose for a total of 2000 pounds of dried treated sludge. The sludge will be shipped to New Mexico State University for the feeding studies and land application studies. (auth)

3170 CHARACTERIZATION OF RADIATION-RESISTANT VEGETATIVE BACTERIA IN BEEF. Welch, A. B.; Maxcy, R. B. (Univ. of Nebraska, Lincoln). Appl. Microbiol.; 30: No. 2, 242-250(Aug 1975).

Ground beef contains numerous microorganisms of various types. The commonly recognized bacteria are associated with current problems of spoilage. Irradiation, however, contributes a new factor through selective destruction of the microflora. The residual microorganisms surviving a nonsterilizing dose are predominantly gram-negative coccobacilli. Various classifications have been given, e.g., Moraxella, Acinetobacter, Achromobacter, etc. For a more detailed study of these radiation-resistant bacteria occurring in ground beef, an enrichment procedure was used for isolation. By means of morphological and biochemical tests, most of the isolates were found to be Moraxella, based on current classifications. The range of growth temperatures was from 2 to 50 C. These bacteria were relatively heat sensitive, e.g., D_{10} of 5.4 min at 70°C or less. The radiation resistance ranged from D_{10} values of 273 to 2,039 krad. Thus, some were more resistant than any presently recognized spores. A reference culture of Moraxella osloensis was irradiated under conditions comparable to the enrichment procedure used with the ground beef. The only apparent changes were in morphology and penicillin sensitivity. However, after a few subcultures these bacteria reverted to the characteristics of the parent strain. Thus, it is apparent that these isolates are a part of the normal flora of ground beef and not aberrant forms arising from the irradiation procedure. The significance, if any, of these bacteria is not presently recognized. (auth)

3171 MECHANISM OF GAP-FILLING DURING POSTREPLICATION REPAIR OF ULTRAVIOLET DAMAGE IN HAEMOPHILUS INFLUENZAE. Small, G. D. (Brookhaven National Lab., Upton, NY). J. Bacteriol.; 124: No. 1, 176-181(Oct 1975).

Deoxyribonucleic acid (DNA), pulse labeled after ultraviolet irradiation of excision-defective mutants of Haemophilus influenzae, is of lower single strand molecular weight than that of unirradiated cells but approaches the size of DNA from unirradiated cells upon further incubation in growth medium. This gap-filling process is controlled by the rec-1 gene. Gap-filling occurs normally in a temperature-sensitive DNA synthesis mutant at the restrictive temperature showing that normal semiconservative DNA synthesis is not necessary for gap-filling. To test for recombinational events after irradiation, the DNA synthesized after irradiation was radioactively labeled for a short time in medium containing 5-bromodeoxyuridine followed by incubation for various times in nonradioactive, 5-bromodeoxyuridine-containing medium. The DNA was denatured and analyzed isopycnically. The labeled DNA was initially "heavy", but later shifted toward lighter densities. This shift occurred in the temperature-sensitive DNA synthesis mutant at the restrictive temperature and in the recombination-defective mutant rec-2, but was not seen in the rec-1 mutant. The density shift can be interpreted as evidence that rather extensive exchanges occurred between parental DNA and the DNA made after irradiation. These results suggest that such exchanges are important for gap-filling in H. influenzae. (auth)

3172 ROLE FOR DEOXYRIBONUCLEIC ACID LIGASE IN DEOXYRIBONUCLEIC ACID POLYMERASE I-DEPENDENT REPAIR SYNTHESIS IN TOLUENE-TREATED ESCHERICHIA COLI. Billen, D.; Hellermann, G. R.; Stallions, D. R. (Oak Ridge National Lab., TN). J. Bacteriol.; 124: No. 1, 585-588 (Oct 1975).

In a toluene-treated mutant of Escherichia coli K-12 having a temperature-sensitive, conditionally lethal mutation in the structural gene for deoxyribonucleic acid (DNA) ligase, an extensive DNA repair synthesis occurred in x-irradiated cells at the nonpermissive temperature, 42°C. At the permissive temperature, 30°C, nearly normal semiconservative synthesis and limited repair synthesis were observed when DNA ligase was activated by the addition of nicotinamide adenine dinucleotide. (auth)

3173 MICROBIOLOGICAL INVESTIGATIONS ON IRRADIATED SHRIMPS. Muenzer, R. (Institut fuer Strahlentechnologie der Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Lebensm.-Wiss. Technol.; 7: No. 5, 288-290 (Oct 1975). (In German)

Blanched brown shrimps from the German North Sea coast were treated with x-rays at a dose of 100 krad either before or after peeling. A third treatment group was irradiated before and after peeling. Control samples remained untreated or were preserved chemically (benzoic acid). Best results were obtained when shrimps were irradiated after peeling. Total bacterial counts and numbers of staphylococci, enterococci and Enterobacteriaceae were reduced by at least two orders of magnitude. (auth)

3174 AIMS AND PRESENT STATE OF THE RADIATION PROCESSING OF FISHES AND SEAFOOD. Hannesson, Gudlaugur. Ind. Aliment. Agric. (Paris); 91: No. 3, 205-211(1974). (In French).

Acceptability of radurized pasteurized by ionizing radiations or radappertized (sterilized by ionizing radiations) fishery products depends on the irradiated fish quality. Though the sensory test is subjective, it allows a correct estimate of the quality. The correlation that exists between the adulteration degree estimated by chemical tests (T.M.A., total volatile bases, total volatile acids) and the organoleptic quality of the product is very variable. Gamma irradiation causes both qualitative and quantitative changes in the microbial flora. Methods actually used for the quality determination are not very viable: research has to be undertaken to improve them. However, it can be assumed that: quality of radurized fish depends on its initial quality, storage duration, preirradiation storage temperature, and amount of irradiation absorbed. (FR)

3175 AIMS AND PRESENT STATE OF THE RADIATION PROCESSING OF FISHES AND SEAFOOD. Hannesson, G. Ind. Aliment. Agric. (Paris); 91: No. 4, 349-356(1974). (In French).

Gamma irradiation causes both qualitative and quantitative changes in the microbial flora. Selective reduction in the microbial flora may be favorable to the development of Clostridium botulinum. This microorganism is able to produce toxins at refrigeration temperatures and the radurization is not able to eliminate the spores of Clostridium botulinum type E (the most often encountered in fish). Other food infection and food poisoning microorganisms like Salmonella species, Staphylococci, and Enterococci survive radurization. Techniques such as irradiation on board, or combining refrigeration and irradiation may increase the keeping quality time. Public health and economical aspects have to be examined thoroughly. (FR)

3176 BACTERIAL FLORA IN NON-TREATED ORDINARY AND RADIATION DENTAL CARIES. Dachev, B.; Neichev, S. Stomatologiya (Sofia); 55: 281-285(1973). (In Russian).

The authors studied the character of the bacterial flora in non-treated ordinary and radiation caries in individuals aged over 20. They established that in caries media and caries profunda (the microorganisms are principally normal inhabitants of the oral cavity. The streptococci, considered an important factor in the origination of the initial caries, were not increased or decreased in comparison with the other microorganisms. The investigations of the radiation caries do not reveal substantial deviations in the microflora, observed in the ordinary caries. The caries were thought to originate at the same time from a group of microorganisms, most probably not strictly fixed. In the development of the caries, phenomena of bacterial symbiosis and antagonism are manifested, as it can be observed upon normal or pathologically changed mucosa of the oral cavity. (auth)

3177 DNA DEGRADATION IN MINICELLS OF ESCHERICHIA COLI K-12. II. Effect of recA1 and recB21 Mutations on DNA Degradation in Minicells and Detection of Exonuclease V Activity. Khachatourians, G. G. (Univ. of Saskatchewan, Saskatoon); Paterson, M. C.; Sheehy, R. J.; Van Dorp, B.; Worthy, T. E. Mol. Gen. Genet.; 138: 179-192(1975).

The properties of minicell producing mutants of Escherichia coli deficient in genetic recombination were examined. Experiments were designed to test recombinant formation in conjugal crosses, survival following uv-irradiation in cells, and the state of DNA metabolism in minicells. The REC^- phenotypes are unaffected by $min^+/^-$ genotypes in whole cells. In contrast to minicells produced by rec^+ parental cells, minicells from a recB21 strain have limited capacity to degrade linear, Hfr transferred DNA. The lack of a functional recA gene product, presumably involved in inhibiting the recBC nuclease action(s), permits unrestricted Hfr DNA breakdown in minicells produced by a recA1 strain. This results in an increase in TCA soluble products and in the formation of small DNA molecules that sediment near the top of an alkaline sucrose gradient. Unlike the linear DNA, circular duplex DNA from plasmids R64-11 or lambda dv, segregated into the minicells, is resistant to breakdown. By using in vitro criteria, and [^{32}P]-labelled linear DNA from bacteriophage T_7 for substrate, we found that the ATP-dependent exonuclease of the recBC complex (exo V) is present in rec^+ and $recA^-$ minicells, and is lacking in the recB21 mutant. In fact, the absence of a functional exo V in $recBC^-$ minicells results in isolation of larger than average Hfr DNA from minicells. We suggest that recombination (REC) enzymes segregate into the

polar minicells at the time of minicell biogenesis. This system should be useful for studies on DNA metabolism and functions of the recBC and recA gene products. (auth)

3178 EFFECTS OF γ RAYS ON THE CHROMOSOMES OF NITELLA FLAGELLIFORMIS Br. Sarma, Y. S. R. K.; Singh, S. B. (Banaras Hindu Univ. (India). Dept. of Botany). Cytologia (Tokyo); 39: No. 2, 303-308(Jun 1974).

The effects of γ rays on a member of Charophyta viz. Nitella flagelliformis have been studied, subjecting the antheridia to (^{60}Co) γ ray treatment (100 to 500 rads). A study of nuclear division in the spermatogenous filaments of treated antheridia, revealed chromosome fragments both at metaphase and anaphase, formation of rings, anaphase bridges, and rarely of micronuclei. A linear increase in the number of cells showing chromosomal aberrations with increase in dose has been observed. It is significant to note that this alga is more sensitive to γ rays in comparison to Eudorina elegans and Euglena gracilis studied by other workers. The cytological effects of γ rays observed in the present work are almost identical with those produced by x rays (100 to 500 rads) on the same species as reported earlier by Sarma and Khan (1967). (auth)

3179 A NEW RADIO-RESISTANT YEAST OF TRICHOSPORON ORYZAE NOV. SP. ISOLATED FROM RICE. Ito, Hitoshi; Sato, T. (Japan Atomic Energy Research Inst., Takasaki, Gunma. Takasaki Radiation Chemistry Research Establishment); Iizuka, H. Agric. Biol. Chem. (Tokyo); 38: No. 9, 1597-1602(Sep 1974).

A radioresistant asporogenous yeast has been isolated from unpolished new crop rice. On the cultivation of this species, formation of true mycelium, arthrospores, and blastospores were observed, and it could be classified as in one group of the genus Trichosporon. Its taxonomic characteristics were found to be sufficiently different from all the described species in this genus to warrant its description as a new species and was named as Trichosporon oryzae nov. sp. This species exhibited high resistance to γ radiation the same as Pullularia pullulans, and the D_{10} value of radioresistant cells was to be ca. 120 krad 0.067 M phosphate buffer which was about 4 to 5 times larger than that of Saccharomyces cerevisiae. In this study, high resistance to γ radiation was also observed on the species of Trichosporon capitatum and Tr. inkin. (auth)

3180 RECOVERY OF IMPAIRED CELL DIVISION OF UV-IRRADIATED ESCHERICHIA COLI BY SEVERAL CHEMICAL AGENTS AFFECTING CELL MEMBRANE. Yoshiyama, Y.; Nagai, K.; Arima, K.; Tamura, G. (Tokyo Univ. (Japan). Faculty of Agriculture). Agric. Biol. Chem. (Tokyo); 37: No. 3, 527-530(Mar 1973).

The effect of various agents on the cell division of E. coli B(Sm^r) irradiated with ultraviolet (UV) light was examined. It was found that the impaired cell division was reversed by one of various agents such as higher fatty acids, lower alcohols, terpineol, phenethyl alcohol, streptomycin, ribonuclease, and EDTA. These agents, except RNase, showed the maximum activity of recovery just below a concentration causing a complete suppression of cell growth. (auth)

3181 ISOLATION OF HIGHLY RADIORESISTANT BACTERIUM, ARTHROBACTER RADIOTOLERANS NOV. SP. Yoshinaka, T.; Yano, K.; Yamaguchi, H. (Tokyo Univ. (Japan). Faculty of Agriculture). Agric. Biol. Chem. (Tokyo); 37: No. 10, 2269-2275(Oct 1973).

A highly γ-ray resistant bacterium, which has not been described hitherto, has been isolated from water containing mud, fur, and moss at a radioactive hot springs, Misasa, Tottori Prefecture, Japan. This bacterium was Gram-positive, non-sporulating, pink to red colored, and pleomorphic rod at young stage and predominantly coccoid or small short rod at old. The radiosensitivity of this bacterium was lower than that of well-known bacterium Micrococcus radiodurans. When its exponentially growing cells were irradiated in buffer solution aerated sufficiently at room temperature, shoulder dose and D_0 were calculated to be 6×10^5 and 1×10^6 rads, respectively. The morphological, cultural, and physiological characteristics of the bacterium have been studied. These attributes suggested that the organism was a new species, and the name Arthrobacter radiotolerans has been assigned with respect to its high radioresistance. (auth)

3182 BIOCHEMICAL STUDIES ON RADIATION-SENSITIVE MUTATIONS IN BACTERIOPHAGE T4. Ohshima, S.; Sekiguchi, M. (Kyushu Univ., Fukuoka (Japan). Faculty of Science). J. Biochem. (Tokyo); 77: No. 2, 303-311(Feb 1975).

Mutants of bacteriophage T4 which exhibit increased sensitivity to ultraviolet radiation were isolated and their abilities to induce an enzyme system to excise pyrimidine dimers were examined. Among the 16 mutants isolated, 12 were found to be defective in inducing T4 endonuclease V, which catalyzes the formation of dimerspecific breaks in ultraviolet-irradiated DNA. A leaky ν mutant, which exhibits intermediate ultraviolet sensitivity, was also isolated. The mutant induces a low level of endonuclease V and excises only a small amount of dimers in vitro. Three other mutants, as well as x and y mutants, were able to induce both T4 endonuclease V and dimer-excision enzyme (5′ → 3′ exonuclease). (auth)

3183 ^{60}Co γ-RAY IRRADIATION FACILITY FOR PREVENTION OF POTATO GERMINATION. Nishiyama, S.; Shimizu, N.; Takada, S.; Suzuki, H. (Kawasaki Heavy Industries, Ltd., Kobe (Japan)); Tanaka, Y. Kawasaki Giho; No. 55, 40-47(Oct 1974). (In Japanese)

One of the peaceful uses of atomic energy is the prevention of germination of potatoes by ^{60}Co γ-ray irradiation. The Japanese Ministry of Welfare approved irradiated potatoes as the first authorized irradiated food in 1972 and the world's largest practical irradiation facility was established at Shihoro-machi in Hokkaido by Kawasaki Heavy Industries, Ltd. This paper shows the significant points of the building of this plant and what was done as γ-ray countermeasure in equipments design. (auth)

3184 UTILIZATION OF FOOD IRRADIATION AND ITS BACKGROUND. Umeda, K. (National Food Research Inst., Tokyo (Japan)). Kagaku To Seibutsu; 12: No. 8, 532-538(Aug 1974). (In Japanese)

The national project for food irradiation started in 1967. In August, 1972, the plant to utilize irradiation for the first time in the world was established in Shihoro, Hokkaido, Japan. This plant is a ^{60}Co-γ ray irradiation plant for the prevention of germinating of potatoes, with monthly capacity of 10,000 tons. The prevention of germinating of onions has been applied for permission. Other treatments now studied in this project are the insecticide of rice and wheat, the elongation of storage time of Viener sausage and fish-paste by sterilization, and the improvement of preservation of orange, etc. Judging from the present demand and supply conditions in Japan, if 60,000 tons of potatoes would be supplied to two big market, Tokyo and Osaka, from the middle of February to the middle of May, which are the period of higher price of potatoes, the price should be stabilized. This fact shows that two more plants of the same scale will be sufficient. As for onions, 20,000 tons would be treated by the same plant, therefore the same scale plant can stabilize the price by supplying enough amount of treated onions during the off-season from February to April. (Kobatake, H.)

3185 COMPARISON BETWEEN IRRADIATED AND AUTOCLAVED DIETS FOR BREEDING MICE, WITH OBSERVATIONS ON PALATABILITY. Porter, G.; Festing, M. (Medical Research Council Lab., Carshalton, Eng.). Lab. Anim.; 4: 203-213(1970).

Two commercial labratory mouse diets were sterilized by either high-vacuum autoclaving γ irradiation, and then fed to breeding mice of 2 different strains housed as monogamous pairs or trios. There was a statistically significant diet-by-sterilization-method interaction for a total number of mice weaned, although neither the effect of diet nor sterilization method was statistically significant. Thus with diet FFG an average of 45.1 young was weaned per cage on irradiated diet compared with 55.6 on the autoclaved diet, while 51.4 mice were weaned per cage on irradiated Breeding Diet compared with 47.6 on the autoclaved. This result suggests that the effects of sterilization by either method depend on the nature of the diet, so that it should be possible to design diets capable of being sterilized by autoclaving or irradiation. Palatability trials indicated a strong preference for irradiated diet over autoclaved diet. (auth)

Radiation Effects on Plants

Refer also to abstracts 3167 and 3168.

3186 (AECD/MISC-4, pp 87-89) BIOCHEMICAL INVESTIGATION OF EARLINESS IN THE RADIATION INDUCED EARLY FLOWERING MUTANT LINES OF RICE AND JUTE. (Atomic Energy Center, Dacca, Bangladesh). Dec 1974.

In annual technical report, July 1972–June 1973. (Atomic Energy Center, Dacca (Bangladesh)).

3187 (AECD/MISC-4, pp 89-90) BIOCHEMICAL STUDIES OF THE CAUSE OF STERILITY AND ITS REMEDY IN THE RADIATION INDUCED STERILE MUTANT LINES OF RICE. (Atomic Energy Center, Dacca, Bangladesh). Dec 1974.

In annual technical report, July 1972–June 1973. (Atomic Energy Center, Dacca (Bangladesh)).

3188 (AECD/MISC-4, pp 93-95) STUDIES ON RADIATION INDUCED DAMAGES, AND THE EFFECTS OF VARIOUS POST-

IRRADIATION TREATMENTS OF THE REPAIR OF SUCH DAMAGES IN MICROBES AND SEEDS OF HIGHER PLANTS. (Atomic Energy Center, Dacca, Bangladesh). Dec 1974.

In annual technical report, July 1972–June 1973. (Atomic Energy Center, Dacca (Bangladesh)).

3189 (CENA-BC-007) BEHAVIOR OF RICE SEEDS (ORYZA SATIVA L.) SUBMITTED TO GAMMA RADIATION. Marcos Filho, J.; Bragantini, C.; Santos, F. D. P. (Centro de Energia Nuclear na Agricultura, Piracicaba (Brazil)). Nov 1972. 21p. (In Portuguese). INIS.

Rice seeds subjected to various gamma radiation dosages were studied in relation to: seed germination, seedling dry weight and seed vigor, when the seeds were stored after irradiation; and effect of irradiation on yield. Seed germination and seedling dry weight were determined under laboratory controlled conditions. Six radiation dosages from 0.0 to 6.4 krad were used. Seed vigor was determined by the rate of seedling emergence in field plots. The influence of the radiation dosages on yield was evaluated in two field experiments. Ten dosages from 0.0 to 6.4 krad were used. Analysis and discussion of the results showed that the radiation dosages didn't affect the conservation of rice seeds when stored for nine months. The yield was lowered by the 6.4 krad radiation dosage and there was indication that the 0.2 krad way favors yield. (INIS)

3190 (NP-20611) APPLICATION OF ATOMIC ENERGY IN AGRICULTURE. Annual Report, 1974. (Association Euratom-ITAL, Wageningen (Netherlands); Instituut voor Toepassing van Atoomenergie in de Landbouw, Wageningen (Netherlands)). 1975. 195p. Dep. NTIS (US Sales Only) $12.75.

Progress is reported on the following research projects: primary radiation effects on DNA of yeast, Tradescantia pollen, and seeds of Haplopappus gracilis; mutation breeding; radiopreservation of food; radiation genetics of insect pests; genetic studies on tomatoes, potatoes, Nicotiana, and Petunia; uptake of elements by plants; heavy metals in plants and soils; gamma and electron dosimetry; recycling of liquid waste; development of high-efficiency and high-resolution ionographic methods; nucleolar DNA synthesis in rat livers; and diagnosis of dry rot in living trees. (HLW)

3191 NEW PLANT TYPE IN BLACK GRAM. Appa Rao, S.; Padmaja Rao, S.; Jana, M. K. (Indian Inst. of Tech., Kharagpur). Curr. Sci. (India); 44: No. 18, 679-680(20 Sep 1975).

Dry seeds of Phaseolus mungo were treated with different doses of x rays, EMS, and combinations of x rays and EMS. One fertile mutant was found in the progeny; it was characterized by a drastic reduction in length of internodes, petioles, and peduncles. Reciprocal crosses resulted in all normal plants indicating that the mutant character was recessive. (HLW)

3192 INDUCTION OF SOMATIC MUTATIONS IN SOME VEGETATIVELY PROPAGATED ORNAMENTALS BY GAMMA IRRADIATION. Das, P. K.; Ghosh, P.; Dube, S.; Dhua, S. P. (Fertilizer Corp. of India Ltd., Sindri). Technology (Sindri); 11: No. 2-3, 185-188(1974).

Attempts were made to produce mutations in some vegetatively propagated ornamentals by acute and chronic gamma irradiation. Rooted cuttings of Chrysanthemums and dormant bulbs of Dahlias were exposed to 1.5, 2.5, 3.5, and 2.0 to 3.0 kR of acute doses, respectively. In chronic irradiation, potted plants of Bougainvillea, Hibiscus, Allamanda, Achania' Jasminum, and Chrysanthemum were exposed to several dose rates at different isodose arcs in the gamma field. Chronically exposed materials showed decreased growth with increased doses besides various physiological abnormalities, like fused growth, bifurcated leaf and midrib, narrow leathery leaf, and budless growth. With acute irradiation a total of four flower color mutants in Angel Belle, Pride of Midford, R. C. Pinch, and Pink Cloud cultivars of Chrysanthemum and that of three in Croydon Monarch and Black Out cultivars of Dahlia were isolated. In chronic irradiation, two flower form and one flower color mutant have been spotted out in Alipore Beauty, Mutant Alipore Beauty, and Syriacus Pink Double Cultivars of Hibiscus. The Hibiscus mutants were isolated at dose rates of 32, 48, 32 R/hr with total doses of 17.4, 10.6, and 22.2 kR, respectively. Similarly, one flower color mutant was isolated in Ajina Purple cultivar of Chrysanthemum at 24 R/hr with an accumulated dose of 14.5 kR. These mutants are being vegetatively multiplied and some of them have already been stabilized as pure forms. (auth)

3193 GENETIC FINE STRUCTURE ANALYSIS OF MUTANTS INDUCED BY ETHYL METHANESULFONATE. Amano, E. (National Inst. of Genetics, Mishima, Shizuoka (Japan)). Gamma Field Symp.; No. 11, 43-59(Mar 1974).

Ethyl methanesulfonate (EMS) and some other alkylating chemical mutagens are very likely to be point mutation inducers. This has been suggested by higher mutagenicity and lower chromosome aberrations induced, compared to radiations. In mutagenesis experiments on Zea mays which has many convenient genetic markers, many single locus mutants were obtained by EMS treatments. Many types of radiations were also used but only a few mutants were induced by such treatments. Among the marker genes used, waxy (wx) was the most convenient one in the further analysis of the induced mutants. Its phenotype could be examined in pollen and intracistronic recombination could be observed relatively easily. Although the mutants analyzed were only a few, the radiation induced mutants seemed to show typical characteristics of deletions of considerable size, as seen by less survival and no or little recombination. Contrary to this, most of the EMS induced mutants showed higher survival, good segregation ratio and production of Wx recombinants in the heteroallelic hybrid. These would probably support the induction of point mutations. Pollen analysis revealed further the presence of leaky wx mutants which might be missense or base pair substitution mutations. The meaning of leaky mutants in different mutation spectra obtained by different mutagens was discussed. Preliminary mapping of these wx mutants was tried and distribution of the mutant sites indicated that the size of the wx cistron might not deviate very much from about 0.2 map unit. (auth)

3194 EFFECTS OF GAMMA RADIATION ON MORPHOLOGICAL CHANGES AND NUCLEIC ACID CONTENT IN BUDS OF POTATO TUBERS. Chachin, K.; Tatsumi, Y.; Ogata, K. (Osaka Prefectural Univ., Sakai (Japan). Coll. of Agriculture). Engei Gakkai Zasshi; 43: No. 2, 194-198(Sep 1974). (In Japanese)

A study was carried out to determine the effect of gamma radiation on the nucleic acid content on buds of potato tubers and the incorporation of ^{32}P into nucleic acid fractions and to observe the morphological changes in buds of irradiated potato tubers. The dead cells were observed in buds of potato tubers irradiated with above 20 Krad, but in the buds of the 10 Krad-tubers they were a little and some giant cells were observed. The contents of sRNA and rRNA in bud disk (but including cortex tissue) of unirradiated tuber increased from dormant period to breaking period, but they did not increase in bud disk of the tubers irradiated with the doses of 5 and 10 Krad during this physiological turning period of metabolism. The incorporation rates of ^{32}P into sRNA and DNA in bud disk of irradiated tubers were accelerated to some extent at the 5th day after irradiation (dormant period of unirradiated tubers) compared with those in unirradiated ones. It was noted that the incorporation rates of ^{32}P into sRNA and mRNA in the 10 Krad-bud disk decreased between breaking and sprouting period, but not into rRNA and DNA, while the incorporation rates into sRNA, rRNA, DNA, and mRNA in bud disk of unirradiated tubers tended to increase respectively. From these results the mechanism of sprout-inhibition of potato tubers by gamma radiation was discussed in a point of nucleic acid metabolism. (auth)

3195 VEGETATIVE PROLIFERATIONS OF FLORAL SPIKELETS IN ORYZA SATIVA L., 5. Seasonal Change of the Type of Proliferations Which Differentiate in the Spikelets of a Mutant Induced by X-ray Irradiation. Takeoka, Y.; Shimizu, M.; Kuroyanagi, C. (Nagoya Univ. (Japan). Faculty of Agriculture). Nippon Sakumotsu Gakkai Kiji; 43: No. 4, 523-530(Dec 1974). (In Japanese)

The study was carried out to make clear the seasonal change of the type of proliferations differentiated in the spikelets of a mutant induced by x-ray irradiation. Results obtained were as follows: 1. morphological changes seen in the spikelets of the mutant: (1) the number of vascular bundles had increased both in empty glumes and lemma more than usual, and additional differentiation of glumes was also recognized through all seasons. (2) The degenerating tendency of stamens appeared presenting a striking contrast to the increase of glumes mentioned above. (3) Most of spikelet-type (S-type) proliferation occurred from July to October and leafyshoot-type (L-type) one occurred from January to March, showing a striking difference in the type of proliferations by seasons. (4) Especially on December that is the intermediate period when the type of proliferations transformed from the S-type into the L-type, pistillate organs increased remarkably in a spikelet and the pistil-type (P-type) proliferation appeared. 2. Spikelets obtained from normal strain had also various morphological abnormalities, suffering from the influence of low temperature. 3. Referring to the seasonal change of day length through a year, the S-type proliferation occurred on the decreasing period of day length, the L-type one on the increasing period of it, and appearance of the P-type proliferation coincided with the transition period of day length from shortening to lengthening one. From the facts above mentioned, we might be able to draw the following schemes on the influence of temperature and day length upon the type of proliferations: (a) moderate (or high) temperature + day length inclining to short day → the S-type proliferation, (b) low temperature + short day → the P-type proliferation, (c) low tem-

perature + day length inclining to long day → the L-type proliferation. (auth)

3196 THE PRODUCTION OF MUTATIONS BY IONIZING RADIATIONS AND CHEMICAL AGENTS IN RELATION TO THE DUPLICATION OF CHROMOSOMES. Yamaguchi, H. (Tokyo Univ. (Japan). Faculty of Agriculture). Gamma Field Symp.; No. 11, 29-40(Mar 1974).

Since premutational damage was found to be repairable until the period of DNA synthesis, it was considered that DNA metabolism was closely correlated to the process by which premutational state was fixed as stable mutational state, and also that mutation was mainly the error occurred accompanied by the replication. From the experimental result on the relation between X-ray irradiating stage and soaking time, it is considered that chromosomal replication occurs within 72 hours of soaking. It was found that the first S-stage of the shoot apical cells of rice seed, determined by the microautoradiography of ^{3}H-thymidine, was in the period of 57.5 to 60 hours after seed soaking, while in barley seeds, the replication of chromosomal DNA was observed in the period of 13 to 20 hours after soaking. Rice seeds soaked for different time were treated with γ-ray, ^{3}H-thymidine, ethyl methane sulfonate, myleran, or aminopherin: with ^{3}H-thymidine, ethyl methane sulfonate, myleran, or aminopherin: with ^{3}H-thymidine or myleran, mutation occurred only in the case of treatment at S-stage, and with γ-ray or aminopterin, the frequency of occurrence of mutation was highest in the case of S-stage treatment, while with ethyl methane sulfonate, the frequency in the case of G-stage treatment was rather higher. Variation of mutation spectra was also observed when rice seeds soaked for different time were treated with ethylmethane sulfonate. The result that mutation spectra varied with the difference of the stage treating with mutagen indicates the possibility of the control of mutation-inducing process. (Kobatake, H.)

Radiation Effects on Animals

Refer also to abstract 2601.

3197 RADIATION AND AGING. Okada, S. (Tokyo Univ. (Japan). Faculty of Medicine). Hirosaki Igaku; 27: No. 6, 617-624(Jun 1974). (In Japanese)

Radiation-induced, nonspecific life shortening is introduced. The relationship between the mean life span and dose, primary factors for life shortening, and biological, chemical, and physical modifying factors were described. Enzymes and SH protectives were explained as the chemical factors; partial irradiation, low dose rate irradiation and divided irradiation, and neutron rays as the physical factors; and the age and aseptic state at the time of irradiation as the biological factors. Thus, from the elucidation of the mechanism of radiation-induced life shortening, the elucidation of the mechanism of aging was introduced. (JA)

Man

Refer also to abstracts 2995, 3141, 3325, 4838, and 4859.

3198 (AECL-5243) CANCER FOLLOWING MULTIPLE FLUOROSCOPIES. Newcombe, H. B. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Aug 1975. 37p. Dep. NTIS (US Sales Only) $5.00. AECL $1.00.

An epidemiological study for detecting carcinogenic effects of multiple fluoroscopies in Canadian tuberculosis patients, treated in the late 1930's to early 1950's when artificial pneumothorax was a standard procedure, is described with special reference to the shape of the dose-response curve and the risks from low doses of ionizing radiation. Intensive investigation of irradiated human populations has so far failed to yield an indication of the numbers of cancers likely to arise among very large numbers of people who have been exposed to very low doses of radiation. There are now very few irradiated human populations left for study. One irradiated population which has so far been studied on only a limited scale consists of persons who received artificial pneumothorax treatment for tuberculosis, in the course of which they were fluoroscoped repeatedly, usually once or twice at the time of each refill. Those patients who did not receive pneumothorax treatments constitute a suitable control population for such a study. In Canada, there were approximately 140,000 first admissions to tuberculosis institutions in the period from 1938 through 1954 and a substantial proportion of the relevant records are fortunately still in existence and available for study. Roughly half of the patients with pulmonary tuberculosis, in that period, received artificial pneumothorax. The quality of the Canadian records of admissions, discharges, and pneumothorax treatments, for that period, together with the case histories and follow-up records, is in general quite sufficient for such studies. The information by which the patients are identified is usually adequate and the dates of all penumothorax refills are documented in the pneumothorax cards. Difficulties are likely to arise only where some of the records have already been discarded. Thus, if such a study is to be carried out, it should be started in all provinces before further records have to be destroyed because of shortage of storage space. That breast cancer has been caused in women by the fluoroscopies seems clear from the results of preliminary studies, but the data have a number of important limitations for present purposes. These studies are unfortunately not large enough to indicate differences in the risks from various numbers of fluoroscopies. Also, unless the numbers of years at risk in the irradiated and unirradiated groups can be shown to be similar, there is a possibility of bias affecting the comparison. In addition, information on the numbers of malignancies other than breast cancer, in patients of both sexes, would be substantial importance even if no effect of the irradiations could be demonstrated. (auth)

3199 (DHEW/FDA-76-8017) REPORT OF STATE AND LOCAL RADIOLOGICAL HEALTH PROGRAMS. Fiscal year 1974. Miller, L. A. (Food and Drug Administration, Rockville, Md. (USA)). Jul 1975. 70p. NTIS.

This report is the fourteenth of a series based on data collected during fiscal year reviews of 53 state and local radiological health programs. The resources and activities of state and local radiological health programs are presented and summarized from data collected as of June 30, 1974. Summary data are included for fiscal years 1972 through 1974. Resources include data on personnel, funds, and equipment. The program activity areas are basic planning and administration, x-ray survey and control, environmental surveillance, radioactive materials, electronic products, and other radiological health activities. (auth)

3200 (INIS-mf-1236, pp 10-27) INFLUENCE OF THE URANIUM COMPOUND PRODUCTION PLANTS ON THE RADIOACTIVE CONTAMINATION OF THE PERSONNEL AND POPULATION. Bilkiewicz, J.; Pietrzak-Flis, Z. (Centralne Lab. Ochrony Radiologicznej, Warsaw). 1972. (In Polish)

From Polish-German work group meeting; Warsaw, Poland (22 Jun 1970).

In radioactive pollution of environment. (Centralne Lab. Ochrony Radiologicznej, Warsaw (Poland)).

The internal contamination hazard of the personnel of uranium compounds production plant and its influence on the contamination of surrounding population was investigated. The assessment of internal contamination was based on the radium-226 and polonium-210 content in urine and hair of the workers and for the assessment of population hazard radium-226 was determined in diet and particular foodstuffs taken from the surroundings of the plant. It was found that in the investigation period of 32 months 35% of the personnel were contaminated. The contamination level did not exceed permissible values. The greatest percentages of contaminated people were found in the occupation groups which worked in more hazardous conditions. The influence of the production plant on radium-226 content in food was not stated and therefore the plant did not cause the increase of radium-226 intake by the population in surroundings. (auth)

3201 (NP-20707) UNITED STATES NUCLEAR REGULATORY COMMISSION AND THE AGREEMENT STATES: LICENSING STATISTICS AND OTHER DATA. (Nuclear Regulatory Commission, Washington, D. C. (USA)). 21 Oct 1975. vp. NUREG.

Data are summarized on the radiation dose received by personnel due to accidents involving the use of sealed radiation sources or unsealed radioactive materials during the period of January 1 to June 30, 1975. A few of the incidents involved the probability of exposure of the public to low radiation doses. Most of the incidents involved sealed γ sources used for industrial radiography or density gages, lost ^{226}Ra or other γ sources used for implant therapy, or the contamination of laboratory surfaces due to spills of radioactive liquids. Each incident is described and tabulated by states under medical, industrial, academic, and other uses. Data are also included on licenses for radioactive materials storage and waste disposal. (CH)

3202 (ORNL-TM-5102) PRELIMINARY RESULTS OF THE 1975 INTERNATIONAL PERSONNEL MONITORING SURVEY. Becker, K. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. 36p. Dep. NTIS $4.00.

About 70 detailed questions have been answered in mid-1975 by 83 personnel monitoring services in 33 countries, representing almost half a million, or approximately 28 percent, of the world's total radiation workers, as well as by 11 customers of U. S. commercial services. Extensive data are given on many questions

regarding the current system in use, future plans, and experiences, for example on the type(s) of TLD, film and readout instrumentation; monitoring period; applications for extremity and environmental monitoring; advantages and disadvantages of various systems; R and D projects; experience with beta and neutron dosimetry; intentional fake exposures; lower and upper dose limits; record-keeping; and reporting of the results. The larger services in the advanced countries lead in the transition from film to TLD. More than half of the radiation workers already wear TLDs, or will do so within about two years. Important unsolved problems are fast neutron monitoring and the low information content and high initial cost of TLD. The trend is towards large, centralized, automatic services and recordkeeping, with extensive computer use for evaluation and data handling. There is a need for better performance standards and testing, and more information exchange and cooperation between services. (auth)

3203 NEOPLASMS IN PERSONS TREATED WITH X-RAYS IN INFANCY: FOURTH SURVEY IN 20 YEARS. Hempelmann, L. H.; Hall, W. J.; Phillips, M.; Cooper, R. A.; Ames, W. R. (Univ. of Rochester, NY). J. Natl. Cancer Inst.; 55: No. 3, 519-530(Sep 1975).

The incidence of neoplastic disease was determined by a mail survey of 2,872 young adults given x-ray treatments in infancy and of their 5,005 nonirradiated siblings. Newly diagnosed benign and malignant neoplasms appeared more frequently in the irradiated subjects than in their siblings or the age- and sex-matched general population of upstate New York. Only thyroid neoplasms occurred in sufficient numbers to permit statistical analysis for the effects on incidence of sex, age, and dose, and of being in a high-risk group (sub-group C). Thyroid cancers developed earlier in life than did benign neoplasms, especially in boys; benign goiters occurred after smaller doses, predominantly in females. Females had a greater risk of developing thyroid cancer than males--2.3 times for females of all ages and 5 times for young adults. Except for young adult females, there was no definite age effect. The risk of cancer (but not of benign goiter) was proportional to the thyroid dose, with a linear risk coefficient of 2.5/year/million people exposed to 1 rad for the entire irradiated population and 4.0 for subgroup C. The high risk of thyroid cancer in subgroup C may be the result of the high percentage of Jews, who had a 3.4-fold greater risk than non-Jews. Young adult Jewish females had a 17-fold increased risk. An incidental observation was an apparent increased incidence of asthma and rare diseases with abnormal immunologic features in the irradiated population. (auth)

3204 CONTRIBUTION OF RADIODIAGNOSIS TO GENETICALLY SIGNIFICANT DOSE. Pele, J. M.; Ouvrard, R. pp 85-95 of 8. National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French).

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

Surveys were carried out in France on 33,000 X-ray medical examinations. The genetically significant dose to the whole population from roentgenography and fluoroscopy, for typical examinations, should be about 65 mrads. (FR)

3205 THE PROBLEM OF INFORMING PERSONNEL IN RADIOPROTECTION MATTERS. Moreau, J. C. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Protection contre les Rayonnements). pp 229-231 of 8. National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French).

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

Within the context of an information campaign on the dangers of radioactivity, aimed at the personnel of the Saclay Nuclear Research Centre, audiovisual methods are used to make this education more attractive. Photographic mounting with sound tracks have been chosen, the subjects of the first concerning the use of the most important detection instruments in connection with the risks encountered at the CEN Saclay. (FR)

3206 THERAPY OF ACCIDENTAL ACUTE WHOLE-BODY EXPOSURES. Schwarzenberg, L.; Mathe, G. (Hopital Paul Brousse, 94 - Villejuif (France)). pp 13-27 of 8. National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French).

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

Mortality following acute whole-body irradiation was studied in patients following ^{60}Co γ therapy, in six cases of accidental exposures, and through a survey on 133 patients following whole-body radiotherapy. At doses for which mortality is due to hematological injuries a symptomatic treatment till spontaneous recovery will result in a significant decrease of mortality. In case of a dosimetric indication of lethal doses, bone-marrow graft should not be postponed. (FR)

3207 CLINICAL DATA RELEVANT TO 25 CASES OF PARTIAL BODY IRRADIATION. Gongora, R.; Gongora, G. (Institut du Radium, 75 - Paris (France)); Jammet, H. (Institut du Radium, 75 - Paris (France); CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Protection). pp 29-42 of 8. National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French).

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

Following occupational accidental exposures, 25 individuals were followed. The clinical evolution highly varied and the injuries were dependent on the delivered dose and its distribution. (FR)

3208 DOSIMETRY IN CASE OF ACCIDENTAL OVER-EXPOSURES. Parmentier, N. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Service de Protection Sanitaire). pp 53-59 of 8. National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French).

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

The dosimetric information needed for the treatment of over-exposures are reviewed in the light of particular cases of whole-body or local acute over-exposures. (FR)

3209 UTILIZATION OF CHROMOSOME ANALYSIS AS AN IRRADIATION DOSEMETER. Biola, M. T.; Le Go, R. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Section de Radiopathologie). pp 43-52 of 8. National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French).

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

The formation processes of primary chromosomal aberrations and the dose-effect relationship between the rate of the various type of abnormalities and the absorbed dose are summarized, and an indication is given of the specific advantages of the use of lymphocyte chromosome aberrations as biological dosemeters (sensitivity about 15 rems, post-irradiation survival of dicentrics). (FR)

3210 RADIATION PROTECTION AND MEDICAL USE OF RADIOACTIVE SEALED SOURCES. Chatelet, J. (Conservatoire National des Arts et Metiers (CNAM), 75 - Paris (France). Lab. National d'Essais). pp 115-122 of 8. National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French).

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

The conditions of radiation protection required in the medical use of sealed sources are summarized for radium-226, and the present technical possibilities and regulations are considered. (FR)

3211 RADIATION PROTECTION DURING RADIOLOGICAL EXAMINATIONS OF CHILDREN. Claus, D.; Gillet, R.; Wambersie, A. (Louvain Univ. (Belgium)). pp 147-153 of 8. National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French).

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

The dose delivered to children during radiological examinations were assessed and their variations compared with an experimental model. It is shown how to make good radiological examinations limiting the dose delivered to children and reducing the hazard to the medical staff. (FR)

3212 INFLUENCE OF RADIOTHERAPY ON THE IMMUNE RESPONSE OF CANCER PATIENTS. Dubois, J. B.; Serrou, B.; Pourquier, H. (Hopital Saint-Eloi, 34 - Montpellier (France)). Bull. Cancer; 62: No. 1, 11-20(Jan 1975). (In French).

The results of immunological surveillance of 60 patients with advanced ENT, mammary, and bronchopulmonary cancers of Hodgkin's disease, treated only by physical agents are reported. These patients were explored by blastic stimulation testing before, during, and after radiation therapy. The results confirm an immunodepressive effect of radiotherapy which increases as the irradiated areas increase, thus showing the importance of immunological surveillance of the cancer patients especially after irradiation. In effect the correlation existing between the importance of immunological repair after irradiation and a good short-term prognosis lead to plan new radioimmunotherapeutic associations in the treatment of advanced cancers or cancers with a poor prognosis. (FR)

3213 FUNDAMENTAL BIOPHYSICAL ASPECTS OF HIGH-ENERGY RADIATIONS IN CANCER THERAPY. Orton, C. G. (New York Univ., NY). Trans. N. Y. Acad. Sci.; 36: No. 6, 545-560(1974).

The limitations of conventional therapy with x and gamma radiations are reported, and high-energy particulate radiations that exhibit physical and/or biological properties more suitable for cancer therapy are discussed. Specifically, future prospects for radiotherapy with beams of electrons, neutrons, negative pions, protons, alpha particles, and heavy ions are surveyed, and some of the results of clinical trials are analyzed. (auth)

3214 RADIATION PROTECTION CONSIDERATIONS IN THE CARDIAC CATHETERIZATION LABORATORY. Dunlap, J. H. (School of Aerospace Medicine, Brooks AFB, TX). Health Phys.; 29: No. 3, 415-417(Sep 1975).

Radiation protection of both patients and medical personnel involved in cardiac catheterization is discussed. The large radiation dose to the patient and concomitant personnel dose from a fluoroscopic examination is augmented with cardiac catheterization equipment because of the high milliamperage requirements of cinefluorography. Techniques and procedures to control excessive radiation exposure are suggested. (UK)

3215 ELIMINATIONS OF PITUITARY GONADOTROPIC HORMONES IN MEN WITH PROTRACTED IRRADIATION DURING OCCUPATIONAL EXPOSURE. Popescu, H. I.; Klepsch, I.; Lancranjan, I. (Academia de Stiinte Medicale, Bucharest). Health Phys.; 29: No. 3, 385-388(Sep 1975).

A study of the total gonadotropins eliminated in 24-hr-urine samples carried out with 57 men with protracted irradiation during occupational exposures showed a decrease in the amount eliminated in a significant number of subjects ($P < 0.01$). All but one was healthy and did not show any blood cell count alterations. One subject was suffering from a chronic irradiation disease. The film badge records during the last 5 to 10 yr showed doses lower than the maximum permissible. Though the mechanism of the lowering of the gonadotropic hormones secretion is not known, it may be supposed that this decrease contributes to the onset or the persistence of a vicious circle which brings about or keeps and/or aggravates the spermatogenesis alterations existent in subjects with long-term exposure to ionizing radiations. (auth)

3216 APPLICATION TECHNIQUE WITH ^{137}Cs AFTER-LOADING AND INTRACAVITARY RADIOTHERAPY METHOD IN CANCER OF THE UTERINE CERVIX. Mitrov, G.; Pencev, P.; Musmov, M.; Todorov, V. Probl. Onkol.; 2: 143-148(1974). (In Russian)

A method is described for intracavitary radiotherapy of cancer of the uterine cervix by use of single linear ^{137}Cs source and lead protection screens for the bladder and rectum. Two lead screens are used having the form of a quarter of a cylinder. They are adequately inserted in an individual vaginal moulage made of siliconrubber. The most important advantages of the method are: It allows the performance of intracavitary radiotherapy in only one procedure, with no risk of complications, since vaginal lavage is available. The indications for intracavitary radiotherapy are appreciably extended because the method can be applied both in cases of considerably strictured vagina and in the vaginal variant of cancer of the uterine cervix. The afterloading is readily and rapidly performed. The radiation load to the bladder and rectum does not exceed 5000 R. (auth)

3217 PROGRESSIVE LOSS OF IMMUNE STATUS AND EMERGENCE OF AUTO-ANTIBODIES FOLLOWING RADIATION THERAPY ON HODGKIN'S DISEASE. Gowland, G.; Stone, J.; Roberts, B. E.; Wilson, J.; Cook, L. (UK); (Cookridge Hospital, Leeds (UK); Leeds General Infirmary (UK)). Acta Radiol., Ther., Phys., Biol.; 13: No. 4, 313-318(1974).

A case of stage IIb Hodgkin's disease in a 72-year-old female patient who was irradiated is described. It is postulated that radiation therapy induced a progressive depression in her immune status with respect to cell mediated (T-cell) response. This in turn resulted in a loss of low dose tolerance of auto-antigens and the production of auto-antibodies. Attention is drawn to the possible consequences of irradiation particularly in the elderly and the potential value of serial monitoring of immune status as a guide to clinical progress and management. (auth)

3218 EFFECT OF RADIATION TREATMENT ON CELL-MEDIATED IMMUNE RESPONSE IN CARCINOMA OF THE BREAST. Glas, U.; Wasserman, J. (Karolinska Sjukhuset, Stockholm (Sweden); Central Microbiologic Laboratory, Stockholm County Council (Sweden)). Acta Radiol., Ther., Phys., Biol.; 13: No. 1, 83-94(1974).

Patients with carcinoma of the breast were selected randomwise into three groups and treated as follows: preoperative irradiation followed by surgery, surgery followed by post-operative irradiation, and surgery alone. Peripheral blood lymphocytes from the patients were examined before and after the different types of treatment for their response in vitro to stimulation by PPD tuberculin and phytohaemagglutinin (PHA). Both types of irradiation induced lymphopenia. A statistically significant decrease in stimulability by PPD tuberculin and a less evident decrease by PHA were observed after preoperative as well as after postoperative irradiation. Surgery did not affect the response of lymphocytes to mitogens or lymphocyte counts. The results indicate an impairment of the cellular immune response following irradiation of carcinoma of the breast. (auth)

3219 SECONDARY ANEMIA IN MALIGNANCY. Prognostic Significance of Hematologic Changes Six Years After Irradiation of Cervical Carcinoma. Einhorn, N.; Reizenstein, P. (Karolinska Sjukhuset, Stockholm (Sweden)). Acta Radiol., Ther., Phys., Biol.; 13: No. 4, 281-287(1974).

Hemoglobin serum folate, iron values, and ESR were determined in cases of carcinoma of the uterine cervix before, one year, and 4 to 6 years after irradiation. Nine of the 41 examined patients died of their tumors. Their pre-treatment values did not differ significantly from those in patients with a favorable prognosis but the ESR and the serum folate values were more pathologic after one year than the values in patients with more favorable prognoses. Twenty-five patients were followed for 4 to 6 years. The hematologic values improved significantly only after 4 to 6 years, possibly because of long-lasting radiation induced local tissue reaction. Persistently pathologic post-treatment serum iron values had no prognostic significance. (auth)

3220 BLADDER AND INTESTINAL INJURIES FOLLOWING INTRACAVITARY IRRADIATION OF CARCINOMA OF THE UTERINE CERVIX. Friberg, L. G.; Johnsson, J. E. (Lund Univ. (Sweden)). Acta Radiol., Ther., Phys., Biol.; 13: No. 4, 288-296(1974).

Bladder and intestinal reactions have been investigated in two materials of carcinoma of the uterine cervix in intracavitary treatment with radium. In one, the intrauterine and the vaginal applicators were locked together in a fixed position and in the other they were unlocked. The frequency of complications was lower in the former material. The reasons for the reaction in the bladder, rectum, and intestinal sections lying in the true pelvis are discussed. (auth)

3221 EFFECTS OF RADIATION THERAPY ON BLOOD-BORNE LEUKOCYTES IN PATIENTS WITH MAMMARY CARCINOMA. Lundell, G. (Karolinska Sjukhuset, Stockholm (Sweden)). Acta Radiol., Ther., Phys., Biol.; 13: No. 4, 307-312 (1974).

The results of absolute and relative leukocyte counts in 48 pre- or postoperatively irradiated patients with mammary carcinoma have been evaluated. A reduction in the number of lymphocytes and segmented neutrophils occurred whereas the juvenile neutrophils, eosinophils, basophils, and monocytes remained unchanged. In the differential leukocyte counts, a significant increase of juvenile and segmented neutrophils, monocytes, eosinophils, and basophils was encountered, however. These results may be of importance in immunologic investigations when lymphocyte stimulation values before and after irradiation are evaluated. (auth)

3222 BLOOD LYMPHOCYTES AFTER RADIATION THERAPY OF CARCINOMA OF PROSTATE AND URINARY BLADDER.

Blomgren, H.; Wasserman, J.; Littbrand, B. (Karolinska Sjukhuset, Stockholm (Sweden); Central Microbiologic Laboratory, Stockholm County Council (Sweden)). Acta Radiol., Ther., Phys., Biol.; 13: No. 4, 357-367(1974).

The peripheral blood lymphocyte population in patients with prostatic and urinary bladder carcinoma was examined before and after local radiation therapy. The number of blood lymphocytes after therapy was reduced from 30 to 50%. The frequency of lymphocytes bearing membrane bound receptors for activated complement, thymus-independent cells, decreased significantly, whereas the frequency of lymphocytes binding sheep erythrocytes, thymus-dependent cells remained essentially the same. The relative response of the lymphocytes to PHA was unchanged, whereas their stimulation by PPD in vitro was significantly impaired following irradiation. (auth)

3223 BONE MINERAL CONTENT OF THE FEMORAL NECK AFTER IRRADIATION. Dalen, N.; Edsmyr, F. (Kungliga Karolinska Mediko-Kirurgiska Institutet, Stockholm (Sweden)). Acta Radiol., Ther., Phys., Biol.; 13: No. 2, 97-101(1974).

The bone mineral content of the femoral neck has been measured in 12 patients with carcinoma of the bladder before, during, and three to twelve months after high-voltage therapy. The mean reduction in the mineral content was only 1.8%, a value that can be ascribed entirely to the normal decrease with age, and deficient physical activity following radiation therapy. (auth)

3224 GASTROINTESTINAL TRANSIT TIME IN OVARIAN CARCINOMA IRRADIATED WITH ^{60}Co. Frankendal, B.; Junghagen, P. (Umeaa Univ. (Sweden)). Acta Radiol., Ther., Phys., Biol.; 13: No. 2, 129-140(1974).

The gastrointestinal transit time was determined in 29 patients undergoing abdominal irradiation for ovarian carcinoma; 16 patients received 200 ml barium sulphate and 13 patients a 300 ml physiologic contrast meal containing barium sulphate and nutritive substances. The transit time was decreased during irradiation and the physiologic meal demonstrated its prolongation during a roughly 15-day pause in the middle of the treatment series. (auth)

3225 RADIATION THERAPY WITH NEGATIVE PIONS. A Proposal for Clinical Trials. Wideroee, R. Radiat. Environ. Biophys.; 11: 15-20(29 Mar 1974).

Using the 2-component model of radiation a successful treatment scheme for electron therapy is analyzed and the number of surviving tumor cells is calculated. The conversion of anoxic to euoxic cells, which is not well known, is of decisive importance. This uncertainty can be much reduced when negative pions are used. A scheme where pions are supplementing an initial electron programme is considered and calculated. The pion beam needs no "cleaning" from electron contamination but the magnitude of electron doses must be measured. (auth)

3226 DOSE DISTRIBUTIONS IN TISSUE OF A FINGER FROM HANDLING THE SYRINGE CONTAINING RADIOISOTOPE. Maekoshi, H.; Nishizawa, K. (Nagoya Univ. (Japan). Faculty of Medicine); Koga, S. Radioisotopes (Tokyo); 24: No. 1, 59-64 (Jan 1974). (In Japanese)

Detailed information was obtained concerning dose distribution in the subcutaneous tissue of the finger of a person handling a syringe filled with radioisotopes. Measurements of entrance and exit dose rates in a finger phantom were compared with the experimental results of TLD measurements. The size of the cylindrical radiation source was 12 mm x 9 mm or 12 mm x 45 mm and the wall thickness of the plastic syringe was 1 mm in thickness, so that the volume of the radioactive solution was 1 ml or 5 ml, each containing 1 mCi in activity. A water equivalent rectangular solid body of 30 mm x 20 mm x 100 mm in size was assumed as a finger phantom, and actual measurements were performed with a MixDp phantom of the same size. A syringe containing the radioisotope was placed directly on the phantom. The dose absorption rate at a point in the phantom was calculated by assuming that γ-rays from the summation of point sources of 1 mm^3 in size attenuate by self-absorption within the source, by absorption by the wall of syringe and tissue, and also by the use of the inverse square law. Scattered radiation, β-rays and bremsstrahlungs were not considered. Radionuclides used were ^{99m}Tc, ^{131}I, ^{203}Hg, ^{198}Au, and ^{59}Fe. It is possible to know the absorbed dose in the tissue in the vicinity of the surface such as stratum corneum and sweat gland by dose distributions obtained in a cross section of a fingerphantom about the five radionuclides. Entrance dose rate values were almost the same as those of calculated and exit dose rates in measured were higher than that in calculated from 10 to 30 percent. The cause of this high value is considered due to scattered radiations from the phantom which is neglected in calculations. (auth)

3227 COMPARISON OF TWO KINDS OF THE REGULATING MECHANISM IN CONFORMATION TECHNIQUE USING ISOTIME-CURVE METHOD. Ueda, Toshio; Kimura, C. (Aichi Cancer Center, Nagoya (Japan)). Nippon Igaku Hoshasen Gakkai Zasshi; 34: No. 12, 889-897(Dec 1974). (In Japanese)

Conformation radiotherapy is an improved technique approximating homogeneous irradiation of irregular tumor volume with specially designed moving diaphragms. Its history and principle have already been described in detail. In this technique, it requires that each side be moved. There are two methods for generating the signal for diaphragm movement. One is called the point contact method and the other the flat contact method. The author compared both methods in terms of the isotime curve and the actual isodose curve fitness to the expected target area. At a high dose, measured isodose curves agreed well with isotime curves and delineation of dose distribution was easily obtained with isotime curves for clinical purposes. In the point contact method, the larger the ratio of the maximum diameter to the minimum one of the irregular tumor shape, the larger was the difference between the expected target area and the high dose region. The 90% dose region was always smaller than the expected target area. In the flat contact method, the 90% region was always slightly larger than the expected target region. It can be concluded that the flat contact method is superior to the point contact method, because the 90% dose region always coincides with the expected target area. (auth)

3228 REPAIR OF GENES AND CHROMOSOMES AND CELLULAR RECOVERY. Suzuki, K. (National Inst. of Radiological Sciences, Chiba (Japan)). Tanpakushitsu Kakusan Koso; 19: No. 7, 567-570(Aug 1974). (In Japanese)

Repair of genes and chromosomes and cellular recovery were explained. The living body has a capacity to repair and recover genetic damages. DNA, which is easy to receive injuries by ultraviolet, recovers its injuries at the same time by enzymes synthesized in other sunbeams. Its recovery itself receives gene's control. Moreover, it may be that cellular recovery is derived from enzymatic recovery of damages of gene DNA. It is said that mutation by radiation is derived from error of repair system for restoration of damages and the life will be short-lived if the error is too much, but evolution can not develop if error does not occur. Accordingly, gene repair system is one of the important fields in radiobiology as an object of biology to analyze the method of life evolution. (JA)

3229 APPLICATION OF HUMAN CANCER CELLS TO RADIATION THERAPY, 7. Studies on Comparison of Melanoma (HMV) and HeLa S3-1. Kasuga, T.; Ohnuma, N.; Furuse, T.; Takahashi, I.; Kubo, E. (National Inst. of Radiological Sciences, Chiba (Japan)). Igaku No Ayumi; 90: No. 6, 326-335(Aug 1974). (In Japanese)

One of the cultured cancer cell-lines, HMV was compared to HeLa S3-1 on the point of biological findings, radiosensitivity, and radioresistance to low LET radiation, and its radioresistance was discussed in this paper. Human melanoma cell, HMV, showed slighter radiosensitivity to low LET radiation compared to HeLa S3-1. This radioresistance corresponded to the sublethal dose, but the radioresistance and recovery had no corresponding to the lethal dose. HMV cells showed remarkable recovery from irradiation within the range of sublethal dose showing 2 times that of HeLa S3 cells. As the dose of radiation therapy of cancer at a time ranged 150 to 250 R, therapeutic effect depended on the recovery within the range of sublethal dose. When the total dose by fractionated irradiation which provided the survival rate of 1 percent for HeLa cells was assumed to 1, that of HMV cells was estimated as 2.78 showing that HMV cells required almost 2.8 times total dose of HeLa cells. Electronmicroscopic observation of both cells under the condition of x-ray exposure which provided 5 percent of the survival rate revealed the increase of mitochondria in HMV cells which was highly resistant to low LET radiation. On the other hand, HMV cells exposed by fast neutron radiation which provided the same survival rate revealed slight increase of mitochondria, and the morphological and numerical changes were almost the same as those observed in HeLa S3 cells. This fact suggested the correlation between the radioresistance to low LET radiation and the activity and kinetics of mitochondria. (JA)

3230 DOSE-REDUCING METHODS OF X-RAYS EXAMINATION IN INFANTS AND CHILDREN. Koike, N. (Osaka City Pediatrics Health Center (Japan)). Shoni Geka Naika; 6: No. 12, 1109-1115(Dec 1974). (In Japanese)

Dose-reducing methods of x-rays examination in infants and children were studied. An examiner should carefully try to reduce exposure dose to infants and children. Infants and children must be put on the protective apparatus, and be attended with affection. An examiner should try to calm their feeling and avoid their affairs. In addition, he must try to finish the examination as soon as possible at a proper time. The x-ray apparatus by which a large dose of exposure can be done for a short exposure time is desired, as the infants and children somewhat move and the heart

and respiratory rates are high. In order to know the dose of exposure to infants and children, it is necessary to often measure a dose beside the apparatus and in the room. Rephotography is questionable from the point of radiation injury, since excessive radiation is exposured to them. In addition, it is waste not only from economic but also from the time. The protection is fully effective, if it might be carefully done each time on roentgenologic examination of the chest. Children are made to put on wooly nylon swimming wear for children, and fall up on the leader for x-ray examination. Roentgenologic examination of the abdomen and the joints should be carefully done as much as possible, as the sexual glands and directly exposured. In addition, unnecessary regions must be covered with large lead rubber for protection. Roentgenologic examination of the digestive canal must be intermittently done with maintenance of minimum time of fluoroscopy. In the examination of the urinary tract repeated exposure is not necessary, when 60% urographin was intravenously administered at 1-2ml/kg of body wt. in pyelography. In conclusion, it is necessary to calm without urgency, fully pay attention and try to reduce exposure dose. (JA)

3231 TIME FACTOR AND BIOLOGICAL RESPONSE OF ORGANISM. Pernicka, F. (Lab. for Radiological Dosimetry, Prague). Radiochem. Radioanal. Lett.; 22: No. 5, 335-339 (24 Sep 1975).

The influence of dose distribution in time on biological response of the organism is discussed. Blair's model gives the possibility to analyze in a simple way an emergency situation, when the whole-body gamma irradiation occurs. A probable construction of the time dosimeter is proposed. (auth)

3232 MANUAL ON RADIATION PROTECTION IN HOSPITALS AND GENERAL PRACTICE. Volume 3. X-ray Diagnosis. Keane, B. E.; Tikhonov, K. B. Geneva; World Health Organization (1975). 96p.

Methods for the radiation protection of patients and personnel during diagnostic radiography are discussed. The choice of x-ray equipment, the location and design of a hospital radiology department, and the conduct of radiation surveys and personnel monitoring are also discussed. (CH)

3233 CARCINOMA OF THE KIDNEY. Blandy, J. P. (London Hospital). Br. J. Urol.; 46: 120(Feb 1974).

Rescrutiny of the results of adding postoperative radiotherapy to nephrectomy raises the possibility that in some cases the host's defence against the activation of small scattered meastases may be impaired, and no matter what local destruction of the tumor is accomplished, the effect upon the immune defences may be harmful and impair survival. Similar consequences may follow preoperative radiotherapy and only blind prospective controlled studies will determine the truth. However, difficulties arise in carrying out such a prospective study, many of which concern the accuracy of diagnosis before nephrectomy. Increasing experience with ultrasonic scanning and arteriography offers a significant improvement in diagnostic accuracy and the use of needle puncture of the suspicious mass seems justified in selected cases. The unpredictable behavior of carcinoma of the kidney, especially those advanced cases who survive without treatment, forces us to reconsider the role of surgical excision of bulk tumor tissue as well as the possible hazards of radiotherapy. (auth)

3234 OPTICAL EFFECTS OF PIGMENTATION ON TEMPERATURE RISE IN A TWO-LAYER SKIN SIMULANT SYSTEM DURING IRRADIATION. Piergallini, J. R.; Stoll, A. M. (Naval Air Development Center, Warminster, PA). Aerosp. Med.; 45: 485-490(May 1974).

It is demonstrated that, from a knowledge of the thermal and optical properties of each layer of a two-layer system, together with the amplitude and distribution of the energy input, it is possible to predict temperature rises at depth in the second layer of a two-layer system. By varying the optical properties of the first layer and observing the temperature rises at depth in the second layer, the experimental results can be used to verify mathematical expressions for optical and heat transfer processes of the two layers. Such a system was devised to determine the thermal conductivity of intact, living skin by measuring the interface temperature between a silicone rubber patch and the living skin when irradiated. It may also be used in evaluations of other two-layer systems where reflectance, transmittance, and heat transfer properties are known and must be accounted for in the mathematical model. (auth)

Vertebrates

3235 (N-75-17081) RADIATION EFFECTS CONTROL: EYES, SKIN. Final Report, 1 October 1969-31 December 1974. Hightower, D.; Smathers, J. B. (Texas Agricultural and Mechanical Univ., College Station (USA). Engineering Experiment Station). Dec 1974. Contract NAS9-9053. 148p. (NASA-CR-141612). NTIS $5.75.

Adverse effects on the lens of the eye and the skin due to exposure to proton radiation during manned space flight were evaluated. Actual proton irradiation which might be encountered in space was simulated. Irradiation regimes included single acute exposures, daily fractionated exposures, and weekly fractionated exposures. Animals were exposed and then maintained and examined periodically until data sufficient to meet the objective were obtained. No significant skin effects were noted and no serious sight impairment was exhibited. (auth)

3236 IMMUNOPROPHYLAXIS AND CYTOTOXIC EFFECTOR CELLS AGAINST EL 4 LEUKEMIA INDUCED IN SYNGENEIC C57BL/6J MICE BY USE OF IRRADIATED EL 4 CELLS. Johnson, T. S. (Veterans Administration Hospital, Miami, FL); Hudson, J. L.; Feldman, M. E.; Irvin, G. L. III. J. Natl. Cancer Inst.; 55: No. 3, 561-567(Sep 1975).

Tumor-specific immunoprophylaxis was achieved in C57BL/6J mice against EL 4 leukosis cell challenge by sensitization of the syngeneic host with multiple ip injections of irradiated EL 4 cells. A minimal radiation dose was used to replication-block EL 4 cells before inoculation, as defined by dose-response analysis of irradiated EL 4 cells. Multiple ip injections of irradiated EL 4 cells stimulated development of significant, yet relatively low, levels of cytotoxic lymphoid activity (CLA) in lymphoid cells of the peritoneal exudate as measured by in vitro ^{51}Cr-release cytotoxicity assays. The specific temporal and frequency dependencies of the inoculation regimen for achieving immunoprophylaxis indicated that, in addition to CLA, other, short-lived, immune processes were important in the tumor rejection. These observations showed the capacity of the C57BL/6J host for tumor-specific immune recognition and rejection of the syngeneic EL 4 leukemia. The tumor rejection could be elicited solely by inoculations of irradiated EL 4 cells and did not require exogenous amplifiers, such as immunoadjuvants, chemical modifiers, and/or allogeneic immune information transfer. (auth)

3237 NATURAL OCCURRENCE OF LYMPHOCYTES SHOWING CYTOTOXIC ACTIVITY IN BALB/c RADIATION-INDUCED LEUKEMIA RL MALE 1 CELLS. Sendo, F. (National Cancer Inst., Bethesda, MD); Aoki, T.; Boyse, E. A.; Buafo, C. K. J. Natl. Cancer Inst.; 55: No. 3, 603-609(Sep 1975).

Spleen cells from untreated young male and female C57BL/6 and C58 mice and of male C3H/He mice showed cytotoxic activity in vitro against BALB/c x-radiation-induced leukemia RL male 1 cells by ^{51}Cr-releasing lymphocyte-mediated cytotoxicity (LMC) tests, but old mice of these strains lacked LMC activity. In contrast, spleen cells from male and female AKR, BALB/c, and DBA/2 mice, and from female C3H/He mice had no appreciable LMC activity. The proportion of active cells in spleens from young (C57BL/6 x BALB/c)F_1 or reciprocal hybrid mice was higher in females than in males. The specificity of the LMC reaction of RL male 1 cells, determined by LMC inhibition assays, was somewhat different from that of previously reported serologic X.1 tests. Thus the antigen detected by LMC has been tentatively designated X.1'. The main effector cells in this system were uncharacterized cells not adherent to glass surfaces or nylon-wool columns. These findings in RL male 1 leukemia extend the evidence for the presence of naturally occurring LMC. With the single unexplained exception of strain C3H/He, the LMC activity against RL male 1 cells, exhibited by untreated mice of various strains, corresponded with a previous classification of mouse strains immunologically as X.1 responders or as X.1 nonresponders according to their ability to reject X.1-positive leukemia cells. (auth)

3238 SIALIC ACID AND NEURAMINIDASE AFTER WHOLE BODY IRRADIATION OF RATS. Kocmierska-Grodzka, D.; Gerber, G. B.; Decock, J. P. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Acta Radiol., Ther., Phys., Biol.; 13: No. 1, 57-64(1974).

Total and free sialic acid as well as soluble neuraminidase were determined in the liver, brain, and spleen of whole-body irradiated rats. The total sialic acid in the liver proved to decrease and that in the spleen and brain to increase whereas the soluble neuraminidase in most organs diminished. The sialic acids in the serum and urine increased so that their excretion might be a reaction suitable for detecting radiation injury. (auth)

3239 GASTROINTESTINAL PROTEIN LOSS INDUCED BY ^{60}Co IRRADIATION OF THE ABDOMEN IN MICE. Frankendal, B. (Umeaa Univ. (Sweden)). Acta Radiol., Ther., Phys., Biol.; 13: No. 1, 65-82(1974).

A tracer, $^{51}CrCl_3$, was injected into female mice irradiated to the abdomen. The feces and urine were collected and the ex-

cretion of the tracer measured. Since ^{51}Cr unites mainly with the plasma protein transferrin, this was taken as a measure of its leakage into the intestine. Mice irradiated with 1000 rad has a significantly increased leakage to the feces. They were examined with this technique at various intervals from the end of irradiation; three days later the leakage into the intestine was greater than that in the controls. This increase persisted throughout the experimental period (75 days). (auth)

3240 EFFECT OF 200, 650, AND 1200 R ON THE INTESTINAL DISACCHARASES AND DIPEPTIDASES. Becciolini, A.; Cariaggi, P.; Arganini, L.; Castagnoli, P.; De Giuli, G. (Florence Univ. (Italy). Istituto di Radiologia). Acta Radiol., Ther., Phys., Biol.; 13: No. 2, 141-152(1974).

The activity of the brush border enzymes after irradiation with 200, 650, and 1200 R initially increased, then decreased and later tended to regain its normal value. The three phases were more or less dependent on the magnitude of the dose. A correlation between the morphologic and enzymatic data was observed only during the phase of maximum injury. (auth)

3241 EXTRACHROMOSOMAL FACTORS IN SPONTANEOUS PULMONARY TUMORIGENESIS IN BALB/c/Cb/Se MICE. Squartini, F. (Univ., Pisa, Italy); Bolis, G. B.; Severi, L. Lavori Ist. Anat. Istol. Patol., Univ. Studi Perugia; 33: 5-15(1973). (In Italian)

Various experiments have been carried out to detect possible extrachromosomal factors involved in spontaneous lung tumorigenesis of BALB/c/Cb/Se mice. During three successive experiments lung tissue from newborn BALB/c mice was grafted subcutaneously into adult syngeneic recipients either panirradiated previously or untreated. Among the latter group of control mice some were thymectomized at birth. Alveolar adenomas have been observed only in the lung grafts recovered from recipients panirradiated before grafting (X^2 14.325; $P < 0.001$). This suggests that panirradiation activates a lung tumor agent in BALB/c mice. Lung tissue from newborn BALB/c mice was grafted subcutaneously into old syngeneic recipients of 16-20 months of age. Only rare grafts have taken and none has showed alveolar adenomas. Whole blood from old BALB/c mice of 16-20 months of age was injected intraperitoneally (0.2 ml.) into newborn recipients of the same strain. 56.2% of the recipients developed lymphatic leukaemia after a mean latency of 399 days. One of the leukaemic animals showed also multiple pulmonary adenomas at autopsy. (auth)

3242 PRINCIPLES AND GENERAL PATHOLOGY OF RADIATION INJURY. Goessner, W. (Technische Univ., Munich). Verh. Dtsch. Ges. Pathol.; 56: 168-187(1972). (In German)

After a discussion of some general principles of cellular radiation biology (types of cell survival curves after irradiation, concept of radiosensitivity, radiosensitivity of cells in relation to cell cycle, type of cellular injury) an outline of general radiation pathology with special emphasis of radiation induced dystrophia, dysplasia and neoplasia is presented. This is followed by a more detailed description of the early and late effects of ionizing radiation upon osseus tissue, especially after incorporation of bone-seeking radionuclides. The induction of osteosarcoma by bone-seeking radionuclides is discussed presenting own animal experiments with the short-lived nuclides Radium-224 and Thorium-227 and human data after incorporation of Radium-226, Radium-228, and Radium-224. In order to establish meaningful radiation protection guides a high research effort is needed to obtain quantitative toxicity data on man and experimental animals. (auth)

3243 RESPONSE OF MOUSE HAEMOPOIETIC COLONY FORMERS TO ACUTE OR CONTINUOUS GAMMA IRRADIATION. Testa, N. G.; Hendry, J. H.; Lajtha, L. G. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Biomedicine; 19: 183-186(20 May 1973).

The effect of single doses of Cs-137 γ-rays or continuous Co-60 γ-rays on mouse haemopoietic colony-forming units (CFU) was investigated using both the in vivo spleen colony assay technique (CFU_s) and the in vitro colony assay technique (CFU_c). The difference in the respective D_0 slopes was maintained during continuous irradiation. At the dose rate used (3.2 rad/hr) the shoulder on the CFU_s survival curve was abolished as expected, but the slopes of the early portions of the survival curves for both CFU_s and CFU_c were similar to those obtained after acute irradiation (600 rad/min). A CFU_c subpopulation which appears after adding red blood cells to the cultures, showed a similar acute radiosensitivity to the whole CFU_c population, but was less depleted under continuous irradiation. The results are discussed in relation to the kinetics of progenitor haemopoietic cell populations after a single, or during a prolonged, stress. (auth)

3244 XENOGENEIC RESISTANCE TO RAT BONE MARROW TRANSPLANTATION. II. Relationship of Hemopoietic Regeneration and Survival. Rauchwerger, J. M.; Gallagher, M. T.; Trentin, J. J. (Baylor Coll., Houston, TX). Biomedicine; 19: 109-11(Mar 1973).

Xenogeneic resistance to rat marrow repopulation of 1100 R irradiated $(C_{57} \times A)F_1$ mice was more strongly expressed in the spleen than in the marrow. A striking dissociation between splenic and marrow regeneration was observed following infusion of graded doses of rat bone marrow. Preferential marrow regeneration occurred in the complete absence of splenic regeneration at certain cell doses, and correlated extremely well with 30-day mouse survival. Several similarities were found to exist between xenogeneic resistance, hybrid resistance, CFU repression, and poor growth phenomenon, suggesting that these are different manifestations of the same phenomenon. (auth)

3245 POSSIBLE ROLE OF PLATELETS AS TRIGGER IN INTRAVASCULAR COAGULATION ASSOCIATED WITH ACUTE HYPERPARATHYROIDISM. Hilgard, P.; Hohage, R.; Schmitt, W.; Minne, H.; Ziegler, R. (Univ., Ulm, Ger.). Acta Univ. Carolinae, Med., Monogr.; 53: 427-432(1972).

Rats bearing a solid Walker carcinosarcoma 256 develop an acute hypercalcemia during the course of tumor growth. Simultaneously the features of microangiopathic hemolytic anemia caused by an intravascular coagulation syndrome are found. Since acute parathyroid hormone induced hyperparathyroidism causes an increased ADP and collagen platelet aggregation it is discussed whether a calcium-platelet interaction represents one of the trigger mechanisms in thrombotic disorders associated with hyperparathyroidism or not. (auth)

3246 EFFECT OF IONIZING RAYS ON ALKALINE PHOSPHATASE ACTIVITY IN HEMATOPOIETIC CELLS OF MOUSE AND RAT. Bartnikowa, W. (Inst. of Oncology, Gliwice, Poland). Folia Haematol. (Leipzig); 100: No. 4, 377-384(1973). (In German)

Activity fluctuations of alkaline phosphatase (alk. Ph.) can be observed in the spleen and bone-marrow cells of mice and rats after a single total body irradiation. This irradiation, however, is not able to produce an activity increase of alkaline phosphatase in those cells which previously had no enzyme activity. On the other hand various strong fluctuations of activity can be proved after irradiation in the same cell type, with the surroundings of the tissue where the cells are located apparently exercising a great influence. (auth)

3247 AGING: ALTERATION OF DNA-PROTEIN INFORMATION. Price, G. B.; Makinodan, T. (Ontario Cancer Inst., Toronto). Gerontologia; 19: 58-70(1973).

The techniques behind the investigation of free-radical, somatic mutation, and DNA-protein deterioration theories are no longer adequate to further our knowledge significantly on the role of DNA-protein complexes in aging dysfunction. Clearly, only the preliminaries were accomplished by studies based on the hypothesis of DNA-protein interactions for aging. As we see it, we urgently need to address ourselves to one simple question at a time, specifically to age changes in the DNA-protein complex, a potential site of primary changes leading to aging dysfunction. (auth)

3248 STEROIDOGENESIS AND CELL STRUCTURE. Biochemical Pursuit of Sites of Steroid Biosynthesis. Tamaoki, B. I. (National Inst. of Radiological Sciences, Chiba, Japan). J. Steroid Biochem.; 4: No. 1, 89-118(1973).

Steroidogenesis is discussed at the different levels of the whole body, organ, cell, subcellular components and biomembrane, in order to pursue the sites of production of steroid hormones in the body. From the information on the sites of steroid transformations in a cell, intracellular transport of steroidal precursors, intermediates, and final products are integrated together with the biosynthetic pathways of the steroid hormone. (auth)

3249 MOVEMENT OF BETA-IRRADIATED EPIDERMAL BASAL CELLS TO THE SPINOUS-GRANULAR LAYERS IN THE ABSENCE OF CELL DIVISION. Etoh, H.; Taguchi, Y. H.; Tabachnick, J. (Albert Einstein Medical Center, Philadelphia). J. Invest. Dermatol.; 64: No. 6, 431-435(1975).

From 13th annual meeting of the American Society for Cell Biology; Miami Beach, FL (14 Nov 1973).

Guinea-pig epidermis was irradiated with 3000 rad of beta rays 1 hr after two injections of [^{3}H]thymidine 5 hr apart (labeled cells in S phase and G_2 phase) or 18 hr after injection (labeled early G_1 cells). In nonirradiated epidermis labeled basal cells divided within 24 hr with daughter cells remaining in the basal layer, and approximately 50 percent of the labeled cells moved into the spinal layer by the 3rd day. Cell division in nonirradiated epidermis diluted the

number of silver grains/nucleus, and lightly labeled cells were found in the granular layer by day 7. Beta irradiation inhibited cell division but it did not slow the rate of transit (ca 8 days) of irradiated labeled cells from basal to granular layer, some of these remaining heavily labeled. Although cell division may play some role in upward movement of basal cells in normal epidermis detachment of a basal cell from the basement membrane and its transit to the granular layer is unimpaired in the absence of cell division. These findings suggest that some radioresistant metabolic function(s), not cell division, is responsible for upward movement of basal cells. (auth)

3250 SYNERGISTIC BIO-EFFECTS OF OIL AND IRRADIATION IN AN AQUATIC ORGANISM, TARICHA GRANULOSA. Lappenbusch, W. L.; Ward, J. M. (Environmental Protection Agency, Rockville, MD). Bull. Environ. Contam. Toxicol.; 9: No. 2, 75-99(Feb 1973).

One group of newts was irradiated but not exposed to oil; a second group was exposed to oil but not irradiated; a third group was exposed to oil and radiation; and the control group received neither oil or radiation. X radiation was administered in doses of 1,000; 2,500; 5,000; or 10,000 rads. The behavior, physical appearances, and mortality of the newts were observed. Histological examinations were made of tissues following death of the ainmals. Graphs are presented to show survival time of newts. The cause of death of irradiated newts was anemia and lesions of the skin and other tissues. High concentrations of oil without irradiation resulted in dilatation of poison glands and skin denudation, and radiosensitivity was increased by exposure to oil. (HLW)

3251 STUDIES ON THE ELECTRONS IRRADIATION ON THE KIDNEY BY USING RADIOISOTOPE RENOGRAPHY. Mukose, Y. (Iwate Medical Coll., Morioka (Japan). School of Medicine). Nippon Igaku Hoshasen Gakkai Zasshi; 34: No. 7, 504-520(Jul 1974). (In Japanese)

The renal function following single irradiation to the left kidneys of rabbits with 12 MeV electrons was investigated by radioisotope renography, and at the same time the histologic findings after irradiation were also studied. (A) The results obtained in the renography are as follows: (1) group 1, irradiated with 1,000 rads. No abnormalities were recorded in the both right and left renograms in 40th week after irradiation. (2) Group 2, irradiated with 2,000 rads. In a few days, the left renogram showed a temporary increase in peak high of renogram (C_M), then it returned to a normal pattern. Fourteen weeks later, the left renogram began to present a slight obstruction pattern and in 30th week, it showed a severe obstruction pattern. On the contrary, the right renogram did not show an abnormal pattern, but in some cases, an increase in C_M were revealed when the left renogram showed a severe obstruction pattern. (3) Group 3, irradiated with 5,000 rads. In a few days, the left renogram showed a temporary and marked increase in C_M and prolongation in time from peak to 50% of peak of renogram (T_H). A few weeks later, the both renograms showed obstruction patterns. The obstruction pattern in right renogram appeared earlier than that in the left renogram and tended to return to the normal pattern. (B) The results obtained in the histologic studies are as follows: (4) group 1, little changes were recognized in the both kidneys until 22nd week. (5) Group 2, in the left kidney, the various changes were manifested as time passed. Namely, after the 20th week, loss and atrophy of majority of the tubules, fibrosis of the interstitium, thickening of the wall of vessels, etc. were recognized. In the right kidney, little changes were recognized. (6) Group 3, the various changes, such as atrophy of the tubules and glomeruli, thickening of the vessel wall and capsules, etc., were noticed in the both kidneys in a few weeks. But, changes in the right kidney were not severer than those in the left kidney. (7) These phenomena of the right kidney in (3) and (6) might be explained being related with allergic involvement. (auth)

3252 PHYSIOLOGICAL AND MORPHOLOGICAL STUDIES FOLLOWING X IRRADIATION OF THE RAT SUBMANDIBULAR GLAND. Miyoshi, Y. (Osaka Dental Coll., Hirakata (Japan)). Shika Igaku; 36: No. 6, 606-630(Dec 1974). (In Japanese)

In order to pursue various radiation injury and radiation protection mechanisms in the oral field, observations were made on an experimental basis, of salivary gland injury and its recovery process. Adult Wistar rats were divided into five groups (one group as non-irradiated control), each consisting of ten rats. Their salivary glands were irradiated with a single dose of 500 R, 1000 R, 2000 R and 4000 R of 200 KVP, 20 mA x-ray respectively. At twenty-four hours, 2 days, 6 days, 13 days, 20 days, 27 days and 34 days after irradiation, seven rats from each group were killed for physiological studies and three rats from each for morphological studies of the salivary glands relative to x irradiation, with the following results; non-irradiated rats' salivary volume following intravenous administration of isoproterenol were constant for the entire 34 days; however, the total protein varied depending upon the body weight and weight of the submandibular gland. Physiologically, radiation injury of the submandibular gland was marked two to six days after x irradiation. Dose effect showed the following ratio of salivary volume to total protein: $Y = 163.6 - 0.0021X$ ($r = 0.94$), $Y = 3.39 - 0.0003X$ ($r = 0.97$). Demonstrating that salivary secretion disturbance was more severe than protein secretion disturbance. Both disturbance became more marked as irradiation dose increased. Smaller irradiation doses resulted faster in recovery of total protein secretion, but recovery of the submandibular saliva did not always depend upon irradiation dose. Radiation disturbance of the submandibular gland developed comparatively slowly and its recovery was quick in the 500 R and 1000 R irradiation groups. It developed early in the 2000 R and 4000 R irradiation groups and lasted 34 days after irradiation. (auth)

3253 STUDIES OF THE PHARMACEUTICAL EFFECT ON IRRADIATED MICE, 5. On Adona (AC-17). Hattori, Y.; Kamikawaji, M. (Kagoshima City Hospital (Japan)). Ketsueki to Myakkan; 5: No. 4, 336-338(Apr 1974). (In Japanese)

A pharmaceutical was administered to irradiated mice for the examination of its influences on the recovery effect. Dd strain mice were subjected to a single whole-body irradiation each of 400 rad and 600 rad of 6 MeV high voltage x rays followed by the subcutaneous injection to the back of 0.5 mg/kg to 50 mg/kg of Ac-17 graded and adjusted to be contained in 0.1 cc for 7 days. The effects on the survival period, survival rate, and changes in body weight were examined and the following conclusion was obtained. $LD_{60/30}$ of the dd strain mice irradiated to 400 rad and $LD_{100/20}$ of those irradiated to 600 rad were obtained. None of the doses of AC-17 resulted in improvement of the survival rate of the 400 rad-irradiated and 600 rad-irradiated groups. The mean number of survival days of the 600 rad-irradiated group was more prolonged than that of the control group. It is important to know the effects of this drug for clinical radiotherapy. (JA)

3254 RADIATION DAMAGE TO DNA AND REPAIR IN MAMMALIAN CELLS. Fujiwara, Y. (Kobe Univ. (Japan). School of Medicine). Tanpakushitsu Kakusan Koso; 19: No. 8, 637-648(Aug 1974). (In Japanese)

127 refs.

The molecular repair processes of DNA damage by ultraviolet rays were discussed concerning the mammalian cells, especially those of higher animals by comparing to the damage by x-rays. There were many unknown mechanism in the molecular repair processes, and the recovery of cells with survival curve showing edge, i.e., "fractionated irradiation recovery" (which is called Elkind recovery, and have correlation with reproduction of "n") has not been sufficiently explored. When various and unknown amounts of damage caused by ionized x rays and several corresponding systems (rebinding-removal and exchange repair, etc.) and their relation to repairing efficiency become clear, the problems of equilibrium and saturated range (which presumably indicated by "n") of the repairing ability of cell to damages (including the nuclear structure to be repaired) will be solved. (JA)

3255 RADIATION INJURY AND EFFECT. Especially of Pathology of Bone Marrow Death, and of the Effect of Fast Neutron Irradiation Against the Radioresistant Tumor, Melanoma. Kasuga, T.; Takazawa, H.; Furuse, T.; Takahashi, I.; Kubo, E. (National Inst. of Radiological Sciences, Chiba (Japan)). Rinsho Byori; 22: No. suppl., 188-201(Aug 1974). (In Japanese)

In this paper, the effects of radiation which caused the radiation hazards, were outlined, and the linear energy transfer (LET) effect, of the fast neutron which was beginning to be used for cancer treatment at National Institute of Radiological Science and The Institute of Medical Science, where the cyclotron was afforded recently, was discussed. The effect of fast neutron irradiation to tumors was discussed mainly with the radioresistant tumor, melanoma. High LET irradiation showed remarkable effect of radioresistant tumors of both experimental and clinical cases, and revealed to be the new useful radiation for cancer treatment. The death caused by bone marrow damage by irradiation was discussed from our experimental data, and stated that the important findings about the direct cause of death by bone marrow damage were hemorrhage in the brain and medulla oblongata, especially in the latter. The liver was commonly considered as radioresistant tissue; however, whole-body irradiation involved the abnormal metabolism, weight changes, and high degree of lipid degeneration of the liver, which were possibly the predisposing factor of the hemorrhage in the brain and medulla oblongata. Damages of local tissues by irradiation, and the relation between radiation and cancerogenesis were also represented in this paper. (JA)

3256 STUDIES ON THE DIFFERENTIATION OF THE PLACENTAL CELLS TRANSPLANTED IN THE LETHALLY IRRADIATED MOUSE. Era, Ichiro (Kumamoto Univ. (Japan). School of Medicine). Nippon Sanka Fujinka Gakkai Zasshi; 26: No. 10, 1097-1104(Oct 1974). (In Japanese)

The following items were studied by transplanting floating solution of the placental cells into the lethally irradiated mouse. Survival rates: some mice survived more than 30 days in proportion to the number of the transplanted placental cells in both groups with intravenous and peritoneal transplantation of the placental cells. All mice died within 15-17 days in the group with no transplantation. Number of peripheral blood corpuscles: temporarily decreased erythrocytes and leukocytes began to be improved 10 to 13 days later. Spleen colony: hematopoietic colony was formed in the spleen 7 or 8 days after transplantation. The number of spleen colony per 10^6 of the placental cells at the 13th, 15th and 19th day of pregnancy were 2.6 ± 0.2, 1.9 ± 0.2 and 0.8 ± 0.3, respectively. Weights of the thymus and the spleen: the weight of the thymus which had been rapidly decreased was gradually improved 4 days later. The weight of the spleen was rapidly increased at the 7th day, and reached to the peak at the 15th day. Since then, it began to decrease, and was normalized at the 25th day. Histological observation: the thymus cortex was filled with pyronine affinitive giant cells 7 days after transplantation. Number of the antibody producing cells: the number of the cells which produced the antibodies against sheep erythrocytes in the spleens transplanted with the placental cells were 18 per 10^6 at the 20th day, 54 at the 30th day, 171 at the 54th day, 158 at the 60th day, and 604 at the 90th day, respectively. From these results, the stem cells with the formation of blood cells were seen in the placenta of mice. In addition, it was concluded that they had a capability to differentiate into cells of bone marrows, lymphocytes, and antibody producing cells. (JA)

3257 BRIEF COMMUNICATION: ONCOFETAL PROTEIN ACCOMPANYING IRRADIATION-INDUCED SMALL-BOWEL ADENOCARCINOMA IN THE RAT. Stevens, R. H.; England, C. W.; Osborne, J. W.; Cheng, H. F.; Richerson, H. B. (Univ. of Iowa, Iowa City). J. Natl. Cancer Inst.; 55: No. 4, 1011-1013(Oct 1975).

A tumor-associated protein was found in tissue derived from an X-irradiation-induced adenocarcinoma in the small bowel of the rat. The protein was associated with the cell membranes of the tumor tissue. It shared common antigenic determinants both with a rat fetal protein and a perchloric acid-soluble protein isolated from the serum of the tumor-bearing rat. (auth)

3258 COMPUTER ANALYSIS OF DEFINED POPULATIONS OF LYMPHOCYTES IRRADIATED IN VITRO. I. Evaluation of Murine Thoracic Duct Lymphocytes. Anderson, R. E.; Olson, G. B.; Shonk, C.; Howarth, J. L.; Wied, G. L.; Bartels, P. H. (Univ. of New Mexico, Albuquerque). Acta Cytol.; 19: No. 2, 126-133(1975)

Computer-assisted morphometric analysis of murine lymphocytes obtained by thoracic duct cannulation demonstrates two populations of cells; the larger population (73 percent) appears to be thymus-derived and the remaining 27 percent is of bone marrow origin. Following exposure to varying amounts of x-radiation, morphologic alterations in both populations are evident. The smaller cell populations are evident. The smaller cell population exhibits some of these changes at lower dose levels than does the larger population. In addition, the character of the radiation-induced changes appears to be different for the two populations of lymphocytes. After 500 rad, the nuclei of the larger population appears unchanged; the nuclei of the population representing 27 percent of the cells have become enlarged and vacuolated and are thought to be edematous. After 2000 rad, the nuclei of the larger population appear pyknotic with coarsely clumped chromatin. In the examined set of cells, the smaller population could no longer be detected after 2000 rad. Such disparate responses to radiation-induced injury may correlate with known differences in immunologic function which serve to distinguish thymic-dependent and bone marrow-derived small lymphocytes. (auth)

3259 REPAIR OF RADIATION DAMAGE IN LEWIS LUNG CARCINOMA CELLS FOLLOWING IN SITU TREATMENT WITH FAST NEUTRONS AND gamma RAYS. Shipley, W. U.; Stanley, J. A.; Courtenay, V. D.; Field, S. B. (Inst. of Cancer Research, Sutton, Eng.). Cancer Res.; 35: No. 4, 932-938(Apr 1975).

Lewis lung tumor cells were irradiated with ^{60}Co gamma rays or cyclotron-produced neutrons in situ as solid s.c. tumors or in vitro as single cell suspensions. Cell survival was assayed by colony formation both in vitro in soft agar and in the lungs of isogeneic recipient mice. Survival curve characteristics measured in vitro were: D_0 equals 111 rads, D/sub q/ equals 342 rads, n equals 22 for gamma-rays, and D_0 equals 61 rads, D/sub q/ equals 46 rads, n equals 2 for neutrons. In situ, the hypoxic fraction was 0.36. Irradiation in situ gave, for the hypoxic subpopulation, D_0 equals 315 rads for gamma-rays and D_0 equals 91 rads for neutrons. The oxygen-enhancement ratio for gamma rays was 2.8 and for neutrons was 1.5. Using the split-dose technique, in which two equal doses were administered, separated by 4 hr chronically hypoxic tumor cells repaired sublethal damage after gamma ray but not after neutron irradiation. Repair of potentially lethal damage, assayed by leaving tumor cells in situ up to 24 hr post-treatment, could not be detected after neutrons, but after gamma rays it was observed as a 3- to 6-fold increase in survival. The repair of potentially lethal damage increased the relative biological effectiveness of neutrons from 3.7 at a survival level of 5 percent when assayed immediately after treatment to 4.7 when assayed 6 to 24 hr after treatment. These observations, primarily limited to the chronically hypoxic subpopulation of tumor cells, suggest that decreased repair of potentially lethal damage as well as sublethal damage may be an important radiobiological difference between the effects of high and low linear energy transfer radiation. (auth)

3260 DIFFERENTIAL SENSITIVITY OF PREIMPLANTATION MOUSE EMBRYOS IN VITRO TO X IRRADIATION. Kirkpatrick, J. F. (Cornell Univ., Ithaca, NY). Biol. Reprod.; 11: No. 1, 18-21(Aug 1974).

A technique was established for in vitro culture of preimplantation mouse embryos, and their development under these conditions was characterized. The embryos were recovered from superovulated mice, cultured and x-irradiated at various stages of development. Preimplantation embryos were also irradiated and grown in vivo. The investigation included a measurement of differential sensitivity of various stages of development and a comparison of the effects of radiation delivered to embryos in vivo and in vitro. The following LD_{50} values (based on development to the blastocyst) were determined for embryos irradiated in vitro: 390 rads, two-cell stage, 570 rads, four-cell stage; 325 rads, morula stage. The LD_{50} values for embryos irradiated and grown in vitro were: 420 rads, two-cell stage; 640 rads, four-cell stage; 340 rads, morula stage. (auth)

Invertebrates

Refer also to abstract 3190.

3261 (AECD/MISC-4, pp 96) EFFECTS OF GAMMA RAYS ON SOME STAGES OF THE LONG HEADED FLOUR BEETLE, LEATHETICUS ORYZEA AND KHAPRA BEETLE, TROGODERMA GRANARIUM E. Ahmed, M. (Atomic Energy Center, Dacca, Bangladesh); Bhuiya, A. D.; Hossain, A. (Atomic Energy Center, Dacca, Bangladesh). Dec 1974.

In annual technical report, July 1972–June 1973. (Atomic Energy Center, Dacca (Bangladesh)).

3262 (AECD/MISC-4, pp 97-99) POSSIBILITY OF INDUCTION OF RADIORESISTANCES IN STORED GRAIN INSECTS. Matin, A. S. M. A.; Bhuiya, A. D.; Salam, A. (Atomic Energy Center, Dacca, Bangladesh). Dec 1974.

In annual technical report, July 1972–June 1973. (Atomic Energy Center, Dacca (Bangladesh)).

3263 (AECD/MISC-4, pp 100-101) DETERMINATION OF THE STERILIZATION DOSES OF ANGOUMOIS GRAIN MOTH, SITOTROGA CEREALELLA OLIVIER. Ahmed, M.; Huda, M. S.; Khan, S. A.; Hossain, A. (Atomic Energy Center, Dacca, Bangladesh). Dec 1974.

In annual technical report, July 1972–June 1973. (Atomic Energy Center, Dacca (Bangladesh)).

3264 (AECD/MISC-4, pp 101-102) RADIATION EFFECTS ON DEVELOPMENTAL STAGES OF CALLOSOBRUCHUS ANALIS FAB. Rahman, R.; Huda, M. S.; Hossain, A. (Atomic Energy Center, Dacca, Bangladesh). Dec 1974.

In annual technical report, July 1972–June 1973. (Atomic Energy Center, Dacca (Bangladesh)).

3265 (AECD/MISC-4, pp 102-104) REARING AND THE EFFECT OF GAMMA RAYS ON LARVAL AND PUPAL STAGES OF JUTE HAIRY CATERPILLAR, DIACRISIA OBLIQUA WALKER. Ahmed, M. (Atomic Energy Center, Dacca, Bangladesh); Bhuiya, A. D.; Huda, M. S.; Bashar, A.; Salam, M. A. Dec 1974.

In annual technical report, July 1972–June 1973. (Atomic Energy Center, Dacca (Bangladesh)).

3266 FIRST IRRADIATION EXPERIMENTS ON THE EGGS OF A COLLEMBOLAN (ANURIDA MARITIMA) WITH A RUBY LASER MICROBEAM. Tamarelle, M. (Bordeaux-1 Univ., 33 - Talence (France); Centre National de la Recherche Scientifique, 33 - Talence (France). Centre de Morphologie Experimentale). C. R. Hebd. Seances Acad. Sci., Ser. D; 280: No. 9, 1147-1150(3 Mar 1975). (In French)

For a constant type irradiation, variations of the general sensibility of the egg are observed according to the stage of development. They are particularly outstanding between the end of the blastula stage and the early germ band stage. Total destruction of the primordial germ cell does not impede the autonomous grouping of the somatic elements of the gonadal rudiment. Irradiations of the dorsal organ show that this organ conditions normal sinking of the embryo into the yolk (so called ventral flexion). (FR)

3267 IRRADIATION-INDUCED STERILITY IN THE MALES AND FEMALES OF CALLOSOBRUCHUS ANALIS (F.) (Bruchidae:Coleoptera). Pajni, H. R. (Panjab Univ., Chandigarh, India). Curr. Sci. (India); 44: No. 18, 669-670(20 Sep 1975).

Pupae of different ages were given four doses of 1,000; 1,500; 2,000 and 2,500 rads of gamma radiation. The reproductive behavior of males and females that emerged was observed. It was concluded that irradiation of two-day old pupae with 1,000 rads and three-day old pupae with 1,500 rads gave best results for pest control operations. (HLW)

3268 HOUSE FLY GENETICS. McDonald, I. C.; Overland, D. E. (Dept. of Agriculture, Fargo, ND). J. Hered.; 64: 247-252 (1973).

A paracentric inversion on chromosome 3 of the house fly, Musca domestica L., was employed as a genetic tool along with mutant markers to recover viable 3-5 translocation homozygotes in this species. The inversion was included directly within the translocations obtained to determine its potential with regard to permanently linking conditional lethal mutations to translocated third chromosomes for use in population replacement control programs: The recombination tests with female translocation heterozygotes indicated the feasibility of utilizing the inversion for such a purpose. The data on recombination involving one of the translocations indicated that the chromosome 5 marker, ocra, lies in the longer of the two arms of the chromosome. (auth)

3269 CONTROL OF HARMFUL INSECTS IN TIMBERS BY IRRADIATION. Doses Required for Sterilization and Inhibition of Emergence of the Minute Pine Bark Beetle. Yoshida, T.; Fukami, J.; Fukunaga, K.; Matsuyama, A. (Institute of Physical and Chemical Research, Wako, Saitama (Japan)). Nippon Oyo Dobutsu Konchu Gakkai-Shi; 18: No. 2, 52-58(Jun 1974). (In Japanese)

The radiosensitivity of the minute pine bark beetle Cryphalus fuluus Niijima was studied for the radiation control of timber insects. The susceptibility to sterilization and inhibition of emergence by gamma irradiation increased in the order of eggs > larvae > pupae > adults. The dose for sterilizing adults was about 15 krad at the most. The dose for inhibiting the emergence was 5 krad for 5-day old eggs, 7 krad for 3rd-instar larvae, and more than 12 krad for pupae, and sterilizing doses for 3rd-instar larvae and pupae were 6 krad and 8 to 9 krad, respectively. (auth)

3270 EFFECT OF GAMMA RADIATION ON MALE PUPAE AND ADULTS OF SPODOPTERA LITURA (F.) (LEPIDOPTERA: NOCTUIDAE) FOLLOWING PUPAL EXPOSURE. Mochida, O.; Miyahara, Y. (Kyushu Agricultural Experiment Station, Chikugo, Fukuoka (Japan)). Appl. Entomol. Zool.; 9: No. 1, 41-47(Mar 1974).

Three- to 5-day-old male pupae were irradiated at 4 to 30 krad with ^{60}Co. Complete sterility was induced in matings of unirradiated females with irradiated males at 8 or more krad. Emergence of normal-appearing males from pupae irradiated at 8 krad was estimated to be about 45%. Longevity of adult males irradiated in the pupal stage gradually declined as the radiation dosage was increased. When unirradiated adult females were paired with irradiated males, longevity of the former was independent of the latter. Pupal sensitivity to gamma radiation differed with age at the time of treatment. When 3-, 5-, and 7-day-old male pupae were irradiated at 4 krad, both the relative proportion of emerged normal-appearing males and the sterile effect were the highest in 5-day-old pupae. (auth)

Radionuclide Effects (Internal Source)

Man

Refer also to abstracts 2987, 2990, 2991, 2995, 3199, and 3325.

3271 (CONF-751043-2) SURVIVAL, CAUSES OF DEATH, AND ESTIMATED TISSUE DOSES IN A GROUP OF HUMAN BEINGS INJECTED WITH PLUTONIUM. Rowland, R. E.; Durbin, P. W. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-10-Eng-38. 17p. Dep. NTIS $4.00.

From workshop on the biological effects and toxicity of Pu-239 and Ra-226; Sun Valley, Idaho, USA (6 Oct 1975).

To determine the relationship between urinary excretion and plutonium body content, 18 persons of short life expectancy were injected with plutonium between 1945 and 1947. Seventeen of these 18 individuals have been identified; eight were found to have survived for at least eight years and four are still alive today (1975). The causes of death of 13 of these individuals have been determined from death certificates; none appear to be related to the administered plutonium. Doses to the liver and to the cells on the surface of bones have been calculated for these plutonium cases. The liver doses do not appear to be high enough to be carcinogenic, but comparison of the bone-surface doses with radium doses that have induced bone tumors indicates that six of these cases have received doses high enough to be considered carcinogenic. However, no bone tumors have yet appeared. (auth)

3272 PROBE CHECK OF COMPUTER DOSIMETRY FOR GYNECOLOGIC IMPLANT THERAPY. Maruyama, Y.; Hoskins, B.; Wrede, D. E.; Sowell, G.; Van Nagell, J. R. Jr. (Kentucky Univ., Lexington (USA)). Acta Radiol., Ther., Phys., Biol.; 13: No. 1, 49-56(1974).

A system has been developed wherein a direct means of monitoring computer dosimetry was investigated. There was linear agreement between probe measurements and expected dose rate calculated by a computer system (correlation coefficient r = 0.988). These two systems were mutually supportive in determining the correctness of loading and in assessing precision of dose near the implanted sources. This system offers a technique for more rigorous analysis of clinical experience. This dual dosimetry system provides a means for greater confidence in implant dosimetry by directly monitoring computer output in gynecologic implant therapy. (auth)

3273 DETERMINATION OF TOTAL TRITIUM IN THE LIVING ORGANISM. Bagdanov, K. M.; Kalinina, E. V.; Kossova, I. V.; Romanovskaya, L. L. (Obninsk State Univ., USSR). Gig. Sanit.; No. 3, 88-90(Mar 1975). (In Russian)

Formulas are given which can be used to determine the total tritium in the living body from values of the total water in the body and the tritium activity in a venous blood sample. (TTT)

3274 SUPRAPUBIC VERSUS URETHRAL BLADDER DRAINAGE IN PATIENTS UNDERGOING INTRACAVITARY RADIUM. Horwitz, D. A.; Buchler, D. A. (Univ. of Wisconsin, Madison). J. Reprod. Med.; 12: 68-70(Feb 1974).

The value of suprapubic bladder drainage was compared to urethral bladder drainage in patients undergoing intracavitary radium placement. A total of 35 patients underwent 70 intracavitary placements. Patients acted as their own controls. No significant difference was noted in the number of positive urine cultures in either group. The number of positive urinary cultures was greater when the dose of irradiation to the bladder was higher. The complications associated with the suprapubic catheter were enough to warrant discontinuing its use for intracavitary radium placements. (auth)

3275 HISTOLOGICAL CHANGES CAUSED BY TREATMENT WITH RADIOACTIVE ISOTOPES. Hirose, F. (Hiroshima Univ. (Japan). Research Inst. for Nuclear Medicine and Biology). Rinsho Byori; 22: No. suppl., 202-214(Aug 1974). (In Japanese)

In the medical use of radioisotope (RI), when it is used for treatment, even the optimal dose is possible to induce of necessity injury of the target tissue or organ or other parts of the body. Since the dose of ^{131}I used for the treatment of hyperthyroidism in the past 20 years is conspicuously the largest of the doses of RI administered to the Japanese, the follow-up survey made for patients with hyperthyroidism was examined with special reference to histological changes. Examined in particular were the incidence of hypothyroidism according to the frequency of ^{131}I administration, histological changes of the thyroid, especially those in the microstructure of epithelial cells, and the incidence of thyroid cancer after ^{131}I therapy. (JA)

Animals

3276 (LA-UR-75-1870) IRRADIATION OF THE LUNG WITH STATIC PLUTONIUM MICROEMBOLI. Holland, L. M.; Prine, J. R.; Smith, D. M.; Anderson, E. C. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-ENG-36. 18p. (CONF-751043-3). Dep. NTIS $4.50.

From workshop on the biological effects and toxicity of Pu 239 and Ra 226; Sun Valley, Idaho, USA (6 Oct 1975).

Syrian hamsters are exposed to selected lung burdens of plutonium-239 contained in 10-mu m diameter microspheres of ZrO_2 ceramic. After injection into the jugular vein, the microspheres lodge in the lung capillaries and remain immobile throughout the

lifetime of the animal. The specific activity of the microspheres is varied from 0.22 to 59 pCi/sphere, and the lung burdens achieved vary from 0.44 to 354 nCi. The distribution in the lung is essentially random except in the groups receiving high numbers of spheres. Since entrapment in the lung approaches 100 percent, there is essentially none of the involvement of other organs seen with inhalation methods. Hamsters are also exposed intratracheally to ^{210}Po to compare the results from an experiment in which other organs are involved and in which a high tumor yield may be anticipated. Tumor production in the microemboli experiment has been quite low, and the overall damage to the lung has been minimal in comparison to the intratracheal experiments with ^{210}Po or with published data from aerosol experiments. (auth)

3277 LIVER AND SPLEEN IN RATS AFTER INTRAVENOUS INJECTION OF LIPIODOL ULTRA-FLUIDE AND ^{99m}Tc-SULPHIDE COLLOID. Jonsson, K.; Olin, T.; Ahlstroem, C. G.; Landberg, T.; Moeller, T.; Naversten, T. (Lund Univ. (Sweden)). Acta Radiol., Ther., Phys., Biol.; 13: No. 3, 249-254(1974).

Microscopy of 19 rats after the injection of Lipiodol Ultra-Fluide alone or with ^{99m}Tc-sulphide colloid revealed small aggregates of lymphocytes and sparse portial cellular infiltrates in the liver of seven of the animals. Giant cell granulomas were evident in the hilar regions of the lungs in two rats; no changes were present in the spleen, lymph nodes, or kidneys. No sarcoid-like granulomas were observed. (auth)

3278 ULTRASTRUCTURE OF ^{90}Sr INDUCED OSTEOSARCOMAS AND EARLY PHASES OF THEIR DEVELOPMENT. Nilsson, A.; Sundelin, P.; Sjoeden, I. (Foersvarets Forskningsanstalt, Stockholm (Sweden); Soedersjukhuset, Stockholm (Sweden)). Acta Radiol., Ther., Phys., Biol.; 13: No. 2, 107-128(1974).

The ultrastructure of radiostrontium induced fibroblastic and osteoblastic osteosarcomas and early phases of their development was investigated in CBA-mice. The material was classified by light microscopy into eight different stages of development. Fine structural changes were demonstrated such as folding of the nuclear membrane, hypertrophy of nucleus and nucleolus, disturbed chromatine distribution, and increase in number of polysomes and mitochondria. Virus-like particles were found rarely in overt tumors. Their role as driver or passenger is discussed. (auth)

3279 COMPARISON OF THE EFFECTS OF CHEMICAL, SURGICAL, AND RADIOTHYROIDECTOMY IN SPOTTED MUNIA, LONCHURA PUNCTULATA. Chandola, A.; Thapliyal, J. P. (Banaras Hindu Univ., India). Gen. Comp. Endocrinol.; 22: 128-131(1974).

Surgical and radiothyroidectomy suppressed feather regeneration and increased the weight of the body, liver, gonads, and gonoducts in Spotted Munia. Chemical thyroidectomy (methylthiouracil) differed only in not being able to affect gonad and gonoduct weight, probably because of incomplete impairment of thyroid function. (auth)

3280 CYTOKINETIC ANALYSIS OF ^{89}Sr-INDUCED TRANSPLANTABLE OSTEOGENIC SARCOMA. Manabe, S. (Kanazawa Univ. (Japan). School of Medicine). Chubu Nippon Seikei Geka Saigai Geka Gakkai Zasshi; 16: No. 5-6, 959-970(Nov 1973). (In Japanese)

Examined were changes in the cell cycle due to the infrafemoral passage transplantation of an experimental osteogenic sarcoma induced by injecting ^{89}Sr into mice and those by tumor-aging. Of the transplanted sarcomas in passage, ^{3}H-thymidine was injected into the 21st, 32nd, and 89th sarcomas by the pulse labeling method 2 weeks after the transplantation, and tumor was sampled with the lapse of time to obtain the curve of percentage labeled mitosis. 2, 3, and 4 weeks after the transplantation of the 105th sarcoma, time-course injections of ^{3}H-thymidine were given to the mice by the cumulative labeling method. One hour after each injection tumor tissues were sampled to obtain the curve of percentage labeled cell, and computation of the mitotic index produced the generative time (Gt), premitotic time, synthetic time (St), presynthetic time (Gt_1) and mitotic time. The pulse labeling method resulted in shortening at 28 hours in the 21st generation and at 22 hours in the 32nd and 89th generations. These were mainly due to shortening of the St. The St/Gt was 0.48, 2.80, and 0.32 in the 21st, 32nd, and 89th generations, respectively. It was thought that cell proliferation of a different DNA content from that of the 21st generation was under way in the 32nd and 89th generations. The cumulative labeling method elucidated the presence of an inviable portion where labeling was absent, in addition to the necrotic portion. This indicated the presence of multicentric proliferation. The cell cycle in each week showed the prolongation of the Gt due to the prolongation of the St and Gt caused by tumor-aging. The growth fraction ranged from 0.93 to 0.95 in all weeks, showing no marked changes due to tumor aging. (JA)

Microorganisms

Refer also to abstract 3242.

3281 (CONF-751034-1) DAMAGE TO THE DNA OF MICROORGANISMS FROM DECAY OF INCORPORATED ^{125}I AND THE RELATIONSHIP OF DNA DAMAGE TO LETHAL EFFECTS. Krisch, R. E.; Krasin, F.; Sauri, C. J. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 21p. Dep. NTIS $4.25.

From international conference on molecular and microdistribution of radioisotopes and biological consequences; Julich, F.R. Germany (2 Oct 1975).

Iodine-125 decays by electron capture and is known to cause severe molecular damage to small organic molecules via vacancy cascades. In an examination of the biological effects of this decay mode we have labelled coliphages T1 and T4, as well as E. coli, with ^{125}I-5-iododeoxyuridine, which is incorporated into DNA in place of thymidine. Labelled organisms are generally stored in liquid nitrogen at -196°C during decay and are periodically assayed for loss of viability and for breakage of DNA, using neutral and alkaline sucrose gradient sedimentation techniques. Briefly, our experiments have demonstrated drastic damage to DNA from the decay of incorporated ^{125}I, as would be predicted from the data for small molecules. (auth)

Nuclide Kinetics and Toxicology

Refer also to abstract 2978.

3282 RADIOTOXICOLOGY. Rocquet, G. (Centre de Recherches du Service de Sante des Armees, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France)). pp 67-84 of Radiobiological Seminar on Internal Contamination. Paris, 18-20 March 1974. Jarry, H. (ed.). Montrouge, France; Societe Francaise de Radioprotection ([nd]). (In French)

From radiobiological seminar on internal contamination; Paris, France (18 Mar 1974). (Societe Francaise de Radioprotection, 92 - Montrouge).

Toxicological aspect is generally related to the radioactivity of the elements, except for elements such as U, whose main hazard is chemical. The quantities to determine being very small, problems of efficiency are of utmost importance and the equipment must be operated at the limit of their possibilities. The difficulties of the various methods are considered. (FR)

Man

Refer also to abstracts 2993, 2994, 3684, and 4534.

3283 (LA-UR-75-1610) URANIUM IN THE TISSUE OF OCCUPATIONALLY EXPOSED WORKERS. Campbell, E. E.; McInroy, J. F.; Schulte, H. F. (Los Alamos Scientific Lab., N. Mex. (USA)). Apr 1975. 32p. (CONF-750445-7). Dep. NTIS $4.75.

From conference on occupational health experience with uranium; Arlington, Virginia, USA (28 Apr 1975).

Data are presented on the content of uranium in tissue samples from deceased occupationally exposed uranium workers. Data on the distribution in lungs, lymph nodes, liver, kidneys, and bone tissues are correlated with available data on the urinary excretion of U during the period of occupational exposure. (CH)

3284 TECHNICAL RADIOPROTECTION SHEET FOR RADIOTRACERS. Choquet, R.; Ciapier, F. (Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire). pp 239-245 of 8th National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French)

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

In radioprotection practice where radiotracers are used the value of a technical sheet replying to certain requirements becomes evident. The models proposed are based on three categories of radiotracers and are therefore specific enough to be clear and concise. These categories distinguish between exclusive soft β emitters, hard β emitters, and β-γ emitters. Each model carries the following headings: nuclear characteristics; risk situation; maximum acceptable surface contamination limits; elimination of wastes, other useful data. For high-energy β and β-γ emitters supplement gives information on shielding to be used. (FR)

3285 GAMMA SPECTROMETRY AND HUMAN INTERNAL CONTAMINATION. Andrieu, L. (Centre de Recherches du Service de Sante des Armees, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France)). pp 45-64 of Radiobiological Seminar on Internal Contamination. Paris, 18-20 March 1974. Jarry, H. (ed.). Montrouge, France; Societe Francaise de Radioprotection ([nd]). (In French)

From radiobiological seminar on internal contamination; Paris, France (18 Mar 1974). (Societe Francaise de Radioprotection, 92 - Montrouge).

Whole-body counting is the simplest, easiest, and quickest way of assessing internal contaminations, however it only applies to γ-emitters; X and β-emitters can only be detected by radiochemical analysis of excreta. Gamma spectrometry supplies both a qualitative and quantitative diagnostic procedure. (FR)

3286 METABOLIC MODELS. Mechali, D. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Protection). pp 25-41 of Radiobiological Seminar on Internal Contamination. Paris, 18-20 March 1974. Jarry, H. (ed.). Montrouge, France; Societe Francaise de Radioprotection ([nd]). (In French)

From radiobiological seminar on internal contamination; Paris, France (18 Mar 1974). (Societe Francaise de Radioprotection, 92 - Montrouge).

The mathematical models based on physiological data, and describing the uptake in the whole body or some organs and the excretion of the radionuclide are reviewed. In case of human exposure, on the basis of the evolution of the measurements carried out, the values of some of the parameters of the uptake and excretion functions used in the general model should be assessed. (FR)

3287 RADIOISOTOPE STUDY OF CUTANEOUS PENETRATION OF IONS. Melki, G. Arch. Belg. Dermatol. Syphiligr.; 29: No. 4, 273-286(1973). (In French)

This study, relating to the nautical environment, has consisted of rectifying experimental radioisotopic techniques, tending to quantify in a responsive manner, the event of transcutaneous penetration of ions. The absorption of ions through the skin of a young rat, bathed in radio-active solution, has been studied on the one hand, by the extent of activity of each of the principal organs corresponding to the total activity of the solution; and on the other hand, by the amount of total activity of the animal's body stripped of its skin and put into the scintillation crystal. The penetration of iodine is more important than that of sodium or potassium, and it lasts longer. In man, the application of occlusive anti-brachial dressings allowed the clear demonstration of the absorption of various ions through the skin, of which iodine and also pertechnetate, the easy use of which has sensitized the rest; finally, the decrease in the rate of thyroid uptake of 131-iodine after skin application of a commercial preparation containing cold iodine or thyroxine has provided an indirect method, but responsive in the event of penetration through human skin. This method constitutes, likewise, a means of studying the action of different physical parameters susceptible to influence the absorption of iodine or iodide through the skin. (auth)

Animals

Refer also to abstracts 2696, 2698, and 3397.

3288 (BNWL-SA-5464) DEVELOPMENT OF A DIAGNOSTIC MODEL FOR INHALED PROMETHIUM-147 OXIDE: ANIMAL STUDIES. Shipler, D. B.; Ballou, J. E.; Griffin, B. I.; Nelson, I. C. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract AT(45-1)-1830. 19p. (SR-6/28; CONF-751205-). Dep. NTIS $4.50.

From IAEA international seminar on diagnosis and treatment of incorporated radionuclides; Vienna, Austria (8 Dec 1975).

Rats and beagle dogs were exposed by inhalation to an aerosol containing stable Sm_2O_3 tagged with $^{145}Sm_2O_3$ and $^{143}Pm_2O_3$. The animals were sacrificed at 0, 14 and 30 days post-exposure to compare the kinetics and translocation of ^{145}Sm and ^{143}Pm. Quantitative analysis for ^{145}Sm and ^{143}Pm in several tissues and excreta indicate that the two rare earth elements were mobilized and distributed similarly by the rats and dogs. Results indicate that within the error of the measurement technique, samarium acts as a carrier for promethium. The data also indicate that activities measured in fecal samples could be used to predict lung burdens of ^{147}Pm. At activity levels and sintering temperatures employed in the rat exposures, there was sufficient activity in urine samples to permit its use as an indicator of lung burdens of ^{147}Pm. At activity levels and sintering temperatures employed in the dog exposures, this was not the case. (auth)

3289 (COO-3173-14) EFFECTS OF STABLE IODINE BLOCKING OF EXPOSURE TO RADIOIODINE. Progress Report, November 1, 1974–October 31, 1975. Becker, D. V.; Belshaw, B. E. (Cornell Univ., New York (USA). Dept. of Medicine). 1975. Contract E(11-1)-3173. 16p. Dep. NTIS $4.50.

Results are reported from studies on the influence of dietary iodine intake on the uptake of ^{131}I by the thyroid gland of beagles. A model of iodine kinetics in normal dogs was developed that consists of separate subsystems for iodine, thyroxine, triiodothyronine, and the thyroid gland. The model demonstrates important differences in iodine metabolism and thyroid function between the dog and man. (CH)

3290 TISSULAR AND SUBCELLULAR DISTRIBUTION OF STRONTIUM IN THE RAT. Tine, J.; Rocquet, G. (Centre de Recherches du Service de Sante des Armees, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 - (France)). pp 217-229 of Radiobiological Seminar on Internal Contamination. Paris, 18-20 March 1974. Jarry, H. (ed.). Montrouge, France; Societe Francaise de Radioprotection ([nd]). (In French)

From radiobiological seminar on internal contamination; Paris, France (18 Mar 1974). Also published in Radioprotection (74) v. 9(3) p. 221-229. (Societe Francaise de Radioprotection, 92 - Montrouge).

After injection of ^{85}Sr to rats, a nonnegligible part of the radioactivity was located in soft tissues. For short times of diffusion, lung, kidney, liver, and testicles were the most loaded with cations. With longer times a maximum charge was observed 48 hours after injection of ^{85}Sr. Hypophysis, thyroid, and adrenals concentrated very important quantities of strontium. The distribution of ^{85}Sr in hepatic tissue occurred especially in mitochondria, microsomes, and nuclei. (FR)

3291 ACCUMULATION OF COLLOIDAL ^{198}Au IN NORMAL BONE MARROW OF RABBITS. Microscopic and Autoradiographic Investigation. Saeterborg, N. E. (Umeaa Univ. (Sweden)). Acta Radiol., Ther., Phys., Biol.; 13: No. 3, 205-216(1974).

Inactive or radioactive colloidal gold was administered intravenously to rabbits and the distribution in the red and fat bone marrow investigated by microscopy and by autoradiography. The gold colloid was concentrated to the sinusoidal lining cells of the bone marrow. The accumulation was more extensive in the red than in the fat bone marrow. A rough correlation between the hematopoietic activity of the bone marrow and the accumulation of colloidal gold existed but at microscopy a definite difference existed. No hematopoietic cells accumulated colloid. (auth)

3292 STUDY OF THE ABILITY OF SODIUM HEXAMETAPHOSPHATE TO DECORPORATE RADIOACTIVE STRONTIUM. Bokova, N.; Nikolov, I.; Mihajlov, M.; Kiradziev, G. Khig. Zdraveopazvane; 17: No. 3, 239-243(1974). (In Russian)

The ability of sodium hexametaphosphate to decorporate radioactive strontium at a speeded rate, with reference to dose, time, and method of administration and to combine with other decorporating agents acting by other mechanisms was studied in experiments performed on 315 male sexually mature Wistar rats. All animals received the radionuclide in the form of chloride per os by intubation. Experiments were carried out in three series. In the first one the decorporating effect of sodium hexametaphosphate was determined depending on dose, method, and time of administration. In the second series of experiments the possibility was studied for radionuclide decorporation by sodium hexametaphosphate combined with other decorporating agents. In the third group of experiments the decorporating effect of sodium hexametaphosphate was assayed in the later stages of incorporation of radioactive strontium. Increase in the dose of sodium hexametaphosphate was accompanied by parallel increase in the decorporating effect. Peak effect was obtained with a dose of 1 g/kg administered 10 min and 24 hours after radionuclide incorporation (more than 60 per cent decorporation). In combining sodium hexametaphosphate with other decorporating agents having other mechanisms of action the decorporating effect was essentially the same as with the use of hexametaphosphate alone. In the later terms of radionuclide incorporation sodium hexametaphosphate exerted no decorporating effect. (Abst. Bulg. Sci. Med. Lit.)

3293 STUDY ON THE ELIMINATION OF TRITIUM IN MICE INJECTED WITH TRITIATED WATER. Ueno, Y.; Kawamura, K. (Kyoto Univ.). Health Phys.; 29: No. 3, 413-415(Sep 1975).

The effect of age and metabolic state on the elimination of tritium injected intraperitoneally into female mice has been studied. The existence of a distinct component in T_{eff} (effective half-life) for the first three days after injection was not demonstrated in all the mice under test but those which did show this effect gave a value of $T_{eff} = 2.32 \pm 0.75$ days. A second component from 3 to 7 days was detected in all cases with a mean of $T_{eff} = 4.98 \pm 1.73$ days but the results show that this does not relate to the basic

metabolic activity directly. The T_{eff} values for various organs were calculated with the assumption that the tritium residues were independent of the age of the mouse. The T_{eff} of the brain was found to be longer than that of other organs. (UK)

3294 BONE MARROW ABNORMALITIES AFTER PHENYLHYDRAZINE INDUCED HEMOLYSIS IN RABBITS. Saeterborg, N. E. (Umeaa Univ. (Sweden). Radiologiska Institutionen). Acta Radiol., Ther., Phys., Biol.; 13: No. 4, 345-356(1974).

The uptake of colloidal ^{198}Au in the proximal and distal parts of the tibia was measured in rabbits treated with daily subcutaneous injections of phenylhydrazine. After 4 to 6 days the uptake increased; after 10 days it increased up to three times the values of normal rabbits. The transition of the fat marrow to active marrow was elucidated by intravenously injected gold colloid demonstrating the patent bone marrow capillaries. In the stimulated marrow the increased hematopoiesis started with hyperemia and capillary proliferation followed by hematopoietic cell colonies in the vicinity of newly formed sinusoids. The granulocytic cell colonies appeared earlier than the erythropoietic ones. (auth)

3295 WHOLE BODY AUTORADIOGRAPHIC EXPERIMENTAL STUDY ON UPTAKE OF ^{45}Ca IN RATS AND EMBRYOS. Influence Caused by Low Calcium Diet Intake. Ohsawa, K. (Gifu Univ. (Japan). Faculty of Medicine). Gifu Daigaku Igakubu Kiyo; 22: No. 1, 79-108(Jan 1974). (In Japanese)

The uptake of ^{45}Ca in rats was studied through the whole body autoradiography observation at 4 hours after a single administration of the isotope intraperitoneally. All animals used in this work were male rats, female rats, and pregnant rats of Wistar strain which were fed on the ordinary diet and low calcium diet for certain periods. The uptake of ^{45}Ca in all rats was the highest in hard tissues. The uptake into submandibular glands of fetuses fed on the ordinary diet resembled to that in hard tissues. In digestive tracts, contents in digestive tracts and bladders, the low calcium diet groups showed a considerable low uptake of ^{45}Ca as compared to the ordinary diet groups. In some tissues, including renal cortex, adrenal and red pulp of the spleen, the uptake of ^{45}Ca in the low calcium diet groups was somewhat lower than that, in the ordinary diet groups and those findings were more remarkable in the pregnant rats. In some tissues, including lung, liver, kidney, white pulp of the spleen, pancreas and blood, no significant differences in regard to the uptake of ^{45}Ca were found between the ordinary diet groups and low calcium diet. In placentas and amnions of pregnant rats and those fetuses, the uptake of ^{45}Ca in the low calcium diet groups was only slightly greater than that in the ordinary diet groups. Although brains and spinal marrows in fetuses showed the uptake of ^{45}Ca in every part, the intensity of radioactivity in the low calcium diet groups exceeded that in the ordinary diet groups. (auth)

3296 THE EXPERIMENTAL STUDY ON THE CHANGE OF HYOID UPTAKE OF ^{45}Ca. Kitahora, H. (Gifu Univ. (Japan). Faculty of Medicine). Gifu Daigaku Igakubu Kiyo; 22: No. 2, 177-202(Feb 1974). (In Japanese)

Using ^{45}Ca as the tracer, the calculation of change of hyoid uptake of ^{45}Ca was carried out continuously in rats with the liquid scintillation counter and the autoradiograph. A moderate range of hyoid uptake of ^{45}Ca was observed 30 minutes later after the intraperitoneal administration of ^{45}Ca. It reached the maximum 6 hours later, and it decreased gradually. The range of uptake of ^{45}Ca by the hyoid bone was always higher than that by the molar and the anterior phalangeal bone as the control. As autoradiographic findings concern, its findings well corresponded with that of liquid scintillation counter. That is to say, the uptake of ^{45}Ca in the areas of the periosteum and the joint cartilage of the hyoid bone was increasing within 30 minutes after the administration. 1 hour later, a large quantity of the uptake was observed in the areas of the joint and the marrow, and also was observed slightly even in the area of the substantia compacta. When 6 hours passed after administration, the uptake reached the maximum and it was observed in all the areas of hyoid bone diffusely. The uptake of ^{45}Ca in the area of lingualis as a soft tissue, was higher in the area of the apex of lingua comparing with that of in the area of the radix of lingua within 3 hours after administration. But 3 hours later, the uptake was slightly higher in the latter than the former. The uptake reached the maximum 30 minutes later in the both areas, followed by a rapid fall and it decreased to zero level 24 hours later. To conclude, in the hyoid bone as well as in the other bone, calcium metabolism such as the absorption and reconstruction of bone, is carried on continuously and actively. Furthermore, it is considered that the calcium metabolism of the hyoid bone is more vigorous than that of the molar and the anterior phalangeal bone, because of the peculiarity of its movement. (auth)

3297 AFFINITY OF ^{167}Tm FOR MALIGNANT TUMOR AND BONE. Ando, Atsushi (Kanazawa Univ. (Japan). School of Paramedicine); Hisada, K.; Sakamoto, K.; Shirota, Y. Radioisotopes (Tokyo); 24: No. 2, 109-114(Feb 1975). (In Japanese)

Thulium-170-citrate has recently been reported to concentrate in nonosseous tumor tissue in animal study. We produced ^{167}Tm by $^{168}Yb(\gamma,n)^{167}Yb \xrightarrow{EC} {}^{167}Tm$ reaction which had a suitable property for tumor scanning. To investigate whether or not ^{167}Tm produced by this method has a strong tumor affinity, ^{167}Tm-citrate was intravenously injected in to rats in which Yoshida sarcoma had been subcutaneously transplanted. The distribution of ^{167}Tm in the body was determined at 3, 24, and 48 hours after administration. The ^{167}Tm-citrate (carrier free) and ^{167}Tm-citrate (containing Tm of 5 μg) had the same strong tumor affinity as ^{170}Tm-citrate in the previously reported experiment, but ^{167}Tm-citrate (containing Tm of 50 μg) did not have tumor affinity. ^{167}Tm-citrate (carrier free) and ^{167}Tm-citrate (containing Tm of 5 μg) had a very strong bone affinity, but it was not concluded that ^{167}Tm-citrate was a more excellent bone scanning agent than ^{99m}Tc-labeled phosphonate. The ^{167}Tm-citrate (carrier free) had as strong an affinity for inflammatory tissue as ^{169}Yb-citrate had. From above described results, it was clearly shown that ^{167}Tm-citrate produced in our new method had strong tumor affinity. (auth)

3298 ENHANCED PLUTONIUM ABSORPTION IN IRON-DEFICIENT MICE. Ragan, H. A. (Battelle Pacific Northwest Labs., Richland, WA). Proc. Soc. Exp. Biol. Med.; 150: No. 1, 36-39(Oct 1975).

The total body burden of plutonium 24 or 96 hr following a single gastric intubation was approximately fourfold greater in iron-deficient than in iron-replete mice. There was also a more rapid translocation of plutonium from soft tissues to bone in the iron-deficient mice by 96 hr after gavage. In the iron-replete group only liver concentrations of plutonium increased during the corresponding time period. (auth)

Plants

Refer also to abstracts 2980 and 2987.

New Tracer Techniques

Refer also to abstract 3049.

3299 RADIORECEPTOR ASSAY FOR FOLLICLE-STIMULATING HORMONE. Cheng, K. W. (Univ. of Manitoba, Winnipeg). J. Clin. Endocrinol. Metab.; 41: No. 3, 581-589(Sep 1975).

A highly specific and sensitive radioreceptor assay for FSH has been developed, using partially purified plasma membranes from bovine testes. Highly purified hFSH was radioiodinated by the lactoperoxidase method. The limit of detection of purified hFSH was 1 ng/ml on the basis of 2x standard deviation of the zero value. The assay was applicable for measurements of FSH in serum; however, the sensitivity decreased slightly to 2.5 ng/ml. The precision of the assay was less than +-10 percent within-assays and +-15 percent between-assays as expressed by the coefficient of variation. The assay was highly specific for FSH of various species. Slight inhibition of uptake of ^{125}I-hFSH was observed with LH and TSH; but no competition was seen with 10,000 ng/ml of insulin, prolactin, hGH, hCG, and subunits of LH. Purified hFSH (LER-1575C) was measured to be 200x the potency of the reference FSH/LH (LER-907); and purified ovine FSH (LER-1491) and rat FSH (FSH-I-1) were estimated to be 35x and 71x that of oFSH-S-1 (NIH), respectively. The content of FSH in human pituitary was estimated to be 226.8 +- 118.8 mIU/mg, and the index of discrimination (radioimmunoassay/radioreceptor assay) for pituitary FSH was demonstrated to be 1.71 +- 0.49. For measurements of serum hFSH, the index of discrimination (radioimmunoassay/radioreceptor assay) was demonstrated to be 1.08 +- 0.20. (auth)

3300 STUDY OF INHALED RADIO-ACTIVE POLLUTANTS: I. CURRENT DATA; II. PATHOLOGY; III. VALIDITY OF ANIMAL MODEL. Dose-Effect Relations. Lafuma, J.; Masse, R.; Metivier, H.; Nolibe, D.; Fritsch, P.; Nenot, J. C.; Morin, M. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Section de Pathologie et Toxicologie Experimentale); Skupinski, W. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Niveaux de Contamination Radioactive du Milieu Ambiant et de la Chaine Alimentaire; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Protection); Chameaud, J. (CEA, 87 - Razes (France). Div. Miniere de la Crouzille). pp 307-324 of Broncho-pulmonary Reactions to Airborne Pollutants. Proceedings of the Colloquium, Pont-a-Mousson, France, 18-19 January 1974. Paris, France;

Institut National de la Sante et de la Recherche Medicale (1974). (In French)

From colloquium on broncho-pulmonary reactions to airborne pollutants; Pont-a-Mousson, France (18 Jan 1974).

An attempt has been made to develop an animal model for human industrial exposure to air radiation that will give results applicable to man both qualitatively and quantitatively. Using over 2000 animals, the following studies were made. Radon, rat and occupationally exposed man; plutonium-239 oxide, rat and monkey; 12 different α emitters, rat with different exposure media (aerosol particles) and exposure schedules (acute and chronic). Scrupulous pathological, microscopic, autoradiographic, and ultrastructural analysis of animals followed their deaths. Acute changes are characterized by alveolaredema, capillary and arteriolar thrombosis, and desquamation of type 1 pneumatocytes. There is interstitial pneumonia, hyaline membrane formation, and extensive bronchiolar and alveolar metaplasia. In a study of long-term effects a wide variety of both benign and malignant tumors was discovered. There are variations in species latency and radiation sensitivity. The pathological changes found in these studies are qualitatively very similar to changes found in man. (FR)

3301 BRONCHOGRAPHIC AND RADIOISOTOPIC STUDIES OF BRONCHIAL CLEARANCE. Ducousso, R.; Girerd, E. (Centre de Recherches du Service de Sante des Armees, 92 - Clamart (France)); Nolibe, D.; Metivier, H.; Masse, R. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Protection). pp 65-78 of Broncho-pulmonary Reactions to Airborne Pollutants. Proceedings of the Colloquium, Pont-a-Mousson, France, 18-19 January 1974. Paris, France; Institut National de la Sante et de la Recherche Medicale (1974). (In French)

From colloquium on broncho-pulmonary reactions to airborne pollutants; Pont-a-Mousson, France (18 Jan 1974).

Bronchograms were performed on monkeys and rats after insufflation of iodinated contrast powders. The clearance kinetics of the contrast media were followed radiographically and by radioisotopic whole body and excreta counting. Because of the product's solubility their elimination through the kidney is augmented with increasing deposition in the peripheral airways. Our attempts to slow down clearance by inducing experimental bronchitis or by previous inhalation of plutonium oxide were unsuccessful. Only insufflation of particles with wounding edges was followed by much longer retention than usual. As opposed to tantalum, the slight solubility of the product allows their elimination with time. (FR)

3302 TRANSPORT AND FATE OF LABELLED MOLECULES AFTER APPLICATION OF ^{14}C-GIBBERELLIC ACID TO THE YOUNG LEAVES OF TOMATO PLANTS. Couillerot, J. P.; Bonnemain, J. L. (Lille-1 Univ., 59 - Villeneuve-d'Ascq (France)) C. R. Hebd. Seances Acad. Sci., Ser. D; 280: No. 12, 1453-1456 (24 Mar 1975). (In French)

After application of ^{14}C-GA_3 to the distal leaflet of young leaves (2.5 cm long) of tomato plants, labelled molecules are exported by the donor leaflet. In the first stage, the transport was basipetal, and preferably took place in the tissues of foliar traces; the tracers moved toward the roots at an average speed greater than 4 cm.h^{-1}. One part of the tracers seemed to accumulate in the elongating internodes, whereas a more important part went into the vessels and then was driven upwards to the leaves by the transpiration stream. A high concentration of tracers was localized in the extremity of some leaflets. The guttated fluid contained labelled molecules having for the most part a R_t value similar or nearly similar to the R_f value of GA_3 according to the solvent systems. The exportation of ^{14}C, which was at first very low, continued during the development of the donor leaf. (FR)

3303 DYNAMIC EXPLORATION OF MYOCARDIAL PERFUSION BY CORONARY BLOOD FLOW RADIOISOTOPIC MEASUREMENT DURING AURICULAR PACING. Di Matteo, Jean; Vernejoul, P. de; Vacheron, Andre; Fauchet, Michel; Le Pailleur, Claude (Hospital Necker-Enfants-Malades, 75 - Paris (France)). C. R. Hebd. Seances Acad. Sci., Ser. D; 280: No. 12, 1485-1487 (24 Mar 1975). (In French)

Reproducibility of the radiocardiographic method using ^{42}K has been verified. Coronary blood flow has so been measured in 50 control subjects and coronary heart disease patients, at steady state and during auricular pacing at 150 beats per minute. In control subjects group, under auricular pacing coronary blood flow increases by a mean value of 15%; on the other hand it decreases by a mean value of 32% in coronary heart disease patients bearing obvious coronarography lesions. The cardiac output coronary fraction increases by a mean value of 27% in the control subjects group; it remains unchanged in coronary heart disease patients. On the contrary this coronary fraction increases in a significant way after functional aortocoronary bypass. (FR)

3304 VALUE OF CEREBRAL SCINTIGRAPHIC EXPLORATION USING LABELLED CALCIUM GLUCONATE ^{99m}Tc IN THE DIAGNOSIS OF SPACE-OCCUPYING INTRACRANIAL LESIONS. Mamo, Lysiane (Hopital Lariboisiere, 75 - Paris (France)); Panneciere, C.; Perez, R. (American Hospital of Paris, 92 - Neuilly (France)); Villa, M. (Societa Ricerche Impianti Nucleari, Saluggia (Italy)). Nouv. Presse Med.; 4: No. 11, 795-797(15 Mar 1975). (In French)

In a preliminary communication, the success coefficients of ^{99m}Tc-pertechnetates and of a new labelled molecule: ^{99m}Tc-calcium gluconate, in a group of 32 patients are compared. The results obtained showed the undoubted superiority of the gluconate in comparison with the pertechnetates in the detection of intracranial metastases, and in particular those of the posterior fossa. It proved equally effective as bleomycin labelled with ^{57}Co. Among the other types of tumor studied, the use of the gluconate seems to be particularly indicated for neoplasms of the posterior fossa and in those close to the base of the skull and venous sinuses, given the marked reduction in background noise obtained when this method is used. (FR)

3305 THE USE OF RADIOISOTOPES IN A CARDIOLOGICAL INTENSIVE CARE UNIT. Vacheron, A.; Heulin, A. (Hopital Necker, 75 - Paris (France). Service de Cardiologie); Vernejoul, P. de (Hopital Necker, 75 - Paris (France)). Sem. Hop. Paris; 51: No. 13, 877-881(14 Mar 1975). (In French)

Radioisotopes may be of use in investigation of patients with heart disease on an intensive care unit. These investigations are not traumatic. The radioisotopes are innocuous and reliable, the examinations may be easily repeated and are therefore of great interest in diagnosis and prognosis of cardiovascular disease. (FR)

3306 INDIUM-111 DTPA IN CISTERNOGRAPHY. Moretti, J. L.; Boumati, P. (Centre Hospitalier Universitaire, 94 - Creteil (France)); Vilayleck, S. (Hopital Saint-Andre, 33 - Bordeaux (France). Lab. des Isotopes). pp 97-113 of 8th National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French)

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

The circulation of the cerebrospinal fluid was studied in 11 patients following injection of ^{111}In-DTPA. Because of its biological, radioactive, and chemical characteristics, it is an ideal radiopharmaceutical. (FR)

3307 PREPARATION OF IODINATED TYROSINE METHYL ESTER OF ESTRADIOL FOR RADIOIMMUNOASSAY. Bajpai, P. K.; Dash, R. J.; England, B. G.; Midgley, A. R. Jr. (Univ. of Michigan, Ann Arbor). Eur. J. Obstet., Gynecol. Reprod. Biol.; 41: 591-596(1974).

A reliable method for separating iodinated 17β-estradiol-11α-tyrosine methyl ester with high antibody binding activity from the iodination reaction mixture using chromatography on Sephadex with pH 10 to 11 phosphate buffered saline as eluent has been developed. The same method can also be used for subsequent purification of preparations showing poor antibody binding activity. (auth)

3308 EXPERIMENTAL STUDIES ON THE MECHANISM OF OSSIFICATION USING ^{45}Ca. I. Fresh Autograft and Kiel Bone Graft. Fujimoto, A. (Gifu Univ., Japan). Gifu Daigaku Igakubu Kiyo; 22: No. 2, 228-251(Feb 1974). (In Japanese)

In the autologous bone of the same experimental animal, holes of the same size were prepared. Fresh untreated autologous bone, as the control, and Kiel Bone graft were simultaneously transplanted, followed by observation in a chronological sequence using ^{45}Ca as the tracer. The ilium of the dog was studied by macroscopic observation, Softex radiography, and autoradiographic observation. The skull of a rabbit was also studied by these methods, with the addition of histopathological studies. Under macroscopic observation, Softex radiography, and autoradiographic findings at the first and second month of the untreated wound cavity in the experiment on the dog ilium is studied. After 1 month, the wound cavity transplanted with the Kiel Bone graft showed a state of ossification using Softex, while ^{45}Ca uptake was small in amount. In the autograft portion, however, the Softex picture revealed insufficient ossification in the center, with marked ^{45}Ca uptake. It was not until 2 months later that both Softex and autoradiographic pictures indicated a completion of ossification. In the experiment on the rabbit skull, uptake of ^{45}Ca was extremely pronounced in the 1st and 4th week. Based on Softex and histopathological observation, however, ossification was almost completed in the 4th week. (JA)

3309 THE EFFECT OF THE ^{51}Cr-LABELLING PROCEDURE ON PLATELET AGGREGABILITY. Bjoernson, J. (Ullevaal Sykehus, Oslo (Norway)). Scand. J. Haematol.; 13: 252-259 (1974).

The effect of ^{51}Cr-labelling on ADP and collagen-induced platelet aggregation has been studied. Aggregation decreased with storage, low pH, centrifugation, high citrate and ion concentration, but was uninfluenced by incubation with ^{51}Cr. The effect of pH and citrate proved to be partly reversible. The use of ^{51}Cr-labelling in the quantitation of platelet deposition in experimental thrombi therefore seems justifiable. (SW)

3310 EFFECTS OF THE HERBICIDE 2,4,5-T ON THE INCORPORATION OF ^{14}C-THYMIDINE, ^{3}H-URIDINE AND ^{3}H-L-LEUCINE INTO L 929 CELLS. Dragsnes, L.; Helgeland, K. (Northwestern Univ., Evanston, Ill. (USA)). Acta Pharmacol. Toxicol.; 35: 103-112(1974).

A rapid inhibition of the incorporation of ^{3}H-L-leucine, ^{3}H-uridine, and ^{14}C-thymidine into the macromolecular fraction of L 929 cells was found when 2.25 mM 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) was added to the incubation medium. The reduced incorporation of ^{3}H-uridine and ^{14}C-thymidine could be explained by an inhibitory effect of 2,4,5-T on the uptake of these compounds into the acid-soluble precursor pool, whereas a direct effect on protein synthesis was indicated. Kinetic analysis of the uptake of uridine into the acid-soluble pool indicated that 2,4,5-T inhibited the facilitated transport of this nucleoside into the cell. The overall results are interpreted as indicating that 2,4,5-T induced alterations in the permeability of the cellular plasma membrane. (SW)

3311 PURIFICATION AND ASSAY OF THROMBOPOIETIN. McDonald, T. P.; Cottrell, M.; Clift, R.; Lane, K. (Tennessee Univ., Knoxville (USA)). Exp. Hematol.; 2: 355-361(1974).

Both a hemagglutination-inhibition (HAI) test and a bioassay technique for thrombopoietin (TSF) were used to detect TSF in fractions of partially purified sheep plasma. Sheep were made thrombocytopenic by injection of a platelet specific antisera and bled 2 to 3½ h later when the platelet counts were 0 to 17,000/mm^3; the plasma was fractionated by ethanol precipitation or by DEAE-phosphate cellulose column chromatography techniques. After fractionation by ethanol precipitation, two of three fractions (40 to 60 per cent and >60 per cent ethanol) of plasma obtained from platelet-depleted sheep stimulated thrombopoiesis in assay mice and caused a 32- to 128-fold increase in the HAI titer. After DEAE-phosphate cellulose column chromatography at pH 4.5 of TSF-rich plasma, a factor was found in Fraction-II that resulted in a significant ($P < 0.005$) increase in per cent ^{35}S incorporation (225 per cent of control) when compared to a similar fraction from normal sheep plasma. However, when similar TSF-rich plasma was fractionated by column chromatography at pH 5.5 the TSF was recovered in Fraction-III ($P < 0.005$; 220 per cent of control). The HAI assay gave similar results; fractions that produced increased biological TSF activity also resulted in an 8-fold increase in the reciprocal of dilution allowing 3+ agglutination of sensitized RBC. These data indicate that TSF can be partially purified from sheep plasma and detected in fractions by both bioassay and immunoassay procedures. (SW)

3312 SPECIFIC BINDING OF OESTRADIOL BY OESTROGEN INDUCED PROLACTIN SECRETING PITUITARY TUMORS IN RATS. Attramadal, A.; Haug, E.; Naess, O.; Skullerud, K. (Rikshospitalet, Oslo (Norway)). Acta Pathol. Microbiol. Scand., Suppl.; No. 248, 21-32(1974).

16 refs.

Pituitary tumors were induced in Fisher and Sprague-Dawley rats by subcutaneous implantation of diethylstilboestrol pellets. The plasma levels of prolactin were examined by radioimmunoassay and the binding of oestradiol determined by in vitro incubation with ^{3}H-oestradiol. Binding qualities and some of the physical chemical properties of the oestradiol binding component were examined. The pituitary tumors were of nearly the same size in the Fisher and Sprague–Dawley rats, with a mean weight of 244 and 235 mg, respectively. The mammary glands were enlarged and grossly secretory in most of the animals. By light microscopy the ducts and alveoli were heavily distended with milk. The concentration of plasma prolactin was extremely high in both the Fisher and Sprague–Dawley rats with pituitary tumors, with mean values of 25413 ng/ml and 12086 ng/ml, respectively. The cytosol of the pituitary tumor tissue as well as the cytosol fractions of the preoptic area and the anterior and posterior parts of the hypothalamus of the tumor bearing animals possessed specific oestrogen binding components, all with a sedimentation coefficient of approximately 8 S. The sedimentation coefficient of the oestrogen binding component of the pituitary tumor tissue was similar to that of the normal pituitary gland. However, the cytosol of the pituitary tumor tissue exhibited a binding of radioactivity that was ⅓ to ¼ of that bound by the cytosol of the normal pituitary per mg protein. The 8 S binding component was not present in the serum or in the cytosol of striated muscle tissue. The dissociation studies showed that unlabelled oestradiol did not significantly displace radioactivity already bound by the 8 S component. However, the binding was completely eliminated when unlabelled oestradiol was added to the cytosol fractions before the incubation with ^{3}H-oestradiol. Testosterone, progesterone and cortisol were without effect. Heating of the cytosol fractions to 45°C for 30 minutes and treatment with protease completely eliminated the binding of radioactivity. DNase and RNase were both without significant effect except that treatment with RNase resulted in a more rapid sedimentation of the oestrogen binder. (SW)

3313 PURINE METABOLISM IN NEISSERIA MENINGITIDIS. 2. Utilization of Exogenous Adenosine, Guanosine, and Inosine. Jyssum, S. (Rikshospitalet, Oslo (Norway)). Acta Pathol. Microbiol. Scand., Sect. B; 82: No. 6, 885-894(1974).

28 refs.

Whole cells of Neisseria meningitidis are found to utilize exogenous radioactive adenosine with labelling of the adenine, adenosine 5'-monophosphate, adenosine 5'-diphosphate and adenosine 5'-triphosphate pools. Extracts from N. meningitidis were found to have activities corresponding to adenosine nucleosidase (EC 3.2.2.7). No activities corresponding to purinenucleoside phosphorylase (EC 2.4.2.1), adenosine kinase (EC 2.7.1.20) or adenosine deaminase (EC 3.5.4.4) could be demonstrated. Radioactive guanosine or inosine were not found to be utilized by whole cells. A hydrolytic breakdown of guanosine or inosine to guanine and ribose, respectively hypoxanthine and ribose could not be demonstrated in crude extracts. Likewise, the search for activities corresponding to a guanosine kinase or to inosine kinase (EC 2.7.1.73) was altogether negative. (SW)

3314 ON THE STRUCTURE OF RAPIDLY LABELED RAT LIVER RNA. Paus, P. N. (Oslo Univ. (Norway)). Acta Chem. Scand., Ser. B; 28: No. 10, 1225-1233(1974).

28 refs.

Rat liver total RNA, extracted by three phenol methods relying upon 4-aminosalicylate, naphthalene 1,5-disulfonate, and heat, respectively, gave different migration patterns, most pronounced for rapid label. The difference could not be attributed to differential extraction. By the 4-aminosalicylate method, large amounts of rapidly labeled structures sedimenting up to 20,000 S were isolated. These structures, consisting of aggregates of heterogeneous RNA, were examined in the present report. They complied with most of the criteria used to classify giant heterogeneous nucleoplasmic RNA as a separate entity of covalent molecules, but they were not resistant to treatment with dimethyl sulfoxide or to heating in low-ionic-strength acetate buffers or in formaldehyde. When such disaggregating treatment was performed on the RNAs extracted by the different methods, the rapidly labeled RNA > 45 S disappeared, and several additional UV-absorbing constituents appeared in the cold-extracted RNAs. This caused a resemblance in the migration and sedimentation patterns of the different RNAs. Radioactive markers added to the extraction buffers prior to homogenization of the livers did not reveal any degradation during extraction or analysis. The results suggest that giant heterogeneous nucleoplasmic RNA from rat liver could essentially be an artifact of extraction. (SW)

3315 ISOLATION OF ^{32}P-LABELED PHOSPHORYLSERINE AND PHOSPHORYLTHREONINE FROM EHRLICH MOUSE ASCITES TUMOR CELLS SUSPENDED IN DIFFERENT ISOTONIC MEDIA CONTAINING ^{32}P-LABELED ADENOSINE TRIPHOSPHATE. Ronquist, G.; Aagren, G. (Uppsala Univ. (Sweden)). Acta Chem. Scand., Ser. B; 28: No. 10, 1169-1174(1974).

20 refs.

Intact Ehrlich tumor ascites cells were handled under physiological conditions and incubated for short periods with [^{32}P]ATP in isotonic media of varying cationic composition. Labeled phosphorylserine, phosphorylthreonine as well as three additional labeled fractions were isolated from a partial hydrolysate of the phosphoproteins in the outer layer of the plasma membrane. The specific ^{32}P radioactivity was about the same for the phosphorylserine and the phosphorylthreonine fractions as well as for an additional one (peak 1, Fig. 1). A complete amino acid analysis was carried out on the five fractions. As expected, serine and threonine were most abundant in the corresponding phosphorylated fractions. Surprisingly, a high amount of proline was found in the sample corresponding to peak 1, having the same high specific radioactivity as found for phosphorylserine and phosphorylthreonine. Cyclic AMP even in as high a concentration as 1×10^{-4}M did not stimulate a further phosphorylation. Maximal incorporation occurred in the presence of both Na^+ and K^+ as well as Mg^{2+}. If Mg^{2+} was stoichiometrically exchanged for Ca^{2+}, the incorporating activity decreased by more than 80%. If half the amount

of Mg^{2+} was exchanged for Ca^{2+}, the corresponding activity was 50% lower. With only Mg^{2+} and a monovalent cation present choline stimulated more than Na^{+}, which in its turn was more stimulatory than K^{+}. Possible functions of the labeled phosphoproteins are discussed. (SW)

3316 CHANGES IN LABELLING OF RIBONUCLEIC ACID SPECIES FRACTIONATED FROM THE RAT VENTRAL PROSTATE IN RESPONSE TO TESTOSTERONE. Isotalo, A.; Santti, R. S. (Turku Univ. (Finland)). Acta Endocrinol.; 78: 401-416(1975).

The total RNA isolated at various times up to 24 h after testosterone administration from the ventral prostate of castrated rats was labelled either by injecting ^{3}H-orotic acid directly into the ventral prostate 6 h before the animals were killed, or by incubating prostatic tissue in vitro with ^{3}H-uridine for 20 to 60 min. The isolated RNA was separated into tRNA, ribosomal RNA (Q_1 RNA) and two DNA-like RNA fractions (Q_2 and TD RNA) by chromatography on methylated albumin kieselguhr (MAK) columns, and the fractions were further analyzed by sucrose gradient centrifugation. Testosterone given into castrated animals for 12 h, stimulated the labelling of all main fractions. The radioactivity of TD RNA after a 60-min incubation period in vitro with ^{3}H-uridine was approximately twice that seen in the castrated rat, while there was a 3.1- and 2.2-fold increase in the radioactivity of the Q_1 and Q_2 RNA fractions respectively. Kinetics of incorporation of ^{3}H-uridine into different RNA fractions revealed that the hormone facilitated the labelling of the TD RNA fraction relatively more than that of the Q_2 fraction. The injection of ^{3}H-orotic acid into the ventral prostate labelled the Q_1 RNA preferentially. More than 60% of the recovered radioactivity was found in Q_1 RNA (as 18 and 28 S). Testosterone increased markedly (9.4-fold) the labelling of this fraction. It was concluded that testosterone has an activatory effect on the production of ribosomal RNA, and the bulk of the testosterone effect on the total RNA labelling is to be found in this fraction. Furthermore, it seems likely that testosterone also stimulates both the synthesis and processing of DNA-like RNA. (SW)

3317 INHIBITION OF THE UPTAKE OF ^{3}H-DOPAMINE AND ^{14}C-5-HYDROXYTRYPTAMINE IN MOUSE STRIATUM SLICES. Ross, S. B.; Renyi, A. L. (Astra Pharmaceuticals AB, Soedertaelje (Sweden)). Acta Pharmacol. Toxicol.; 36: 56-66(1975).

The inhibitory activities of a number of compounds on the simultaneous uptake of ^{3}H-dopamine (^{3}H-DA) and ^{14}C-5-hydroxytryptamine (^{14}C-5-HT) in the same slices of the mouse striatum were examined. Experiments with inactive DA and 5-HT demonstrated that the uptake of the two amines occurs at different sites. In vitro (+)-amphetamine was 2.7 times more potent than the (–)-isomer whereas in vivo this difference was about 6 times. (+)-Amphetamine was also significantly more active than the (–)-enantiomer on the ^{3}H-DA uptake in striatal slices from the rat. The methylester group in cocaine is essential for the inhibitory activity of cocaine, which had similar potencies on the two uptake mechanisms. Benztropine was much more active on the ^{3}H-DA uptake than on the ^{14}C-5-HT uptake. In vivo the amphetamine derivatives including prolintane and methylphenidate were the most active compounds on the ^{3}H-DA uptake, but the 4-substituted amphetamines were more active on the ^{14}C-5-HT uptake. Among other compounds benztropine was as active as (+)-amphetamine on the ^{3}H-DA uptake. None of the compounds tested seem to be useful as model compounds for the selective inhibition of the Da uptake, since they have other pharmacological effects at lower doses. (auth)

3318 HIGH-VOLTAGE RADIOGRAPHY. Theory and Clinical Application. Reichmann, S.; Helander, C. G. (Sahlgrenska Sjukjuset, Goeteborg (Sweden); Goeteborg Univ. (Sweden)). Acta Radiol., Diagn.; 15: No. 5, 561-569(1974).

A high-voltage technique seems to be more useful than is generally believed provided certain precautions are taken. A theory on the nature of such precautions is presented and discussed. Some clinical applications are described. (SW)

3319 ANGLE DISTORTION IN NARROW BEAM ROTATION RADIOGRAPHY. Saemfors, K. A.; Welander, U. (Centrallasarettet, Boden (Sweden)). Acta Radiol., Diagn.; 15: No. 5, 570-576(1974).

The distortion of a panorama roentgen image of the teeth and jaws exposed with a rotating narrow beam depends on differing proportionality in the image in the horizontal and vertical planes. This distortion may be defined as angle distortion, and has the effect that obliquely positioned structural details in the object will be depicted with a false angulation in the image. The angle distortion has been calculated mathematically. Outside the sharply depicted object plane, angle distortion may be considerable; it is greatest when the projection radii are small, and most marked for structural details in the object that form a large angle with the horizontal plane. (auth)

3320 HOMOGENEITY OF INTENSIFYING SCREENS. Reichmann, S.; Helander, C. G. (Sahlgrenska Sjukhuset, Goeteborg (Sweden)). Acta Radiol., Diagn.; 15: No. 4, 449-453(1974).

The crystal structure of intensifying screens has been investigated. A coarse structure will impair the image quality owing to increased noise termed "structure mottle". Screens of very fine structure have recently been introduced; some new applications for such screens are discussed. (auth)

3321 FUNCTIONAL ISOTOPE PHLEBOGRAPHY OF LOWER EXTREMITIES. Vitek, J.; Huvar, A.; Vrubel, F. (Radiologic Clinic and Surgical Clinic, Brno). Acta Radiol., Diagn.; 15: No. 2, 161-168(1973).

Functional isotope phlebography is a method of assessing normal or insufficient function of the venous system of the leg. The procedure was applied in 30 patients predominantly suffering from varicosities. Three types of functional curves were assessed; these correspond to normal and insufficient function of the venous system as a whole and will reveal occlusion when present. (auth)

3322 SCINTIGRAPHY OF THE PARASTERNAL LYMPHATICS IN THE RABBIT USING TECHNETIUM-99M SULFIDE COLLOID. Goeransson, L. R.; Jonsson, K. (Lund Univ. (Sweden); Lund Univ. (Sweden). Radiofysiska Institutionen). Acta Radiol., Diagn.; 15: No. 2, 169-176(1973).

Parasternal scintigraphy with ^{99m}Tc-S-colloid has been performed in rabbits. The colloid was injected on both sides of the xiphoid process. Hyaluronidase dissolved in the colloid was the most favorable method for enhancing the resorption. (auth)

3323 BLOOD STREAM AND VENTILLATION SCINTIGRAMS. Pulmonary Scintigrams. Ishii, Y.; Ito, H.; Mukai, T.; Suzuki, T.; Torizuka, K. (Kyoto Univ.). Gendai No Shinryo; 16: No. 5, 690-699(May 1974). (In Japanese).

The principle, instruments, and method of ventillation and blood stream scintigrams with ^{133}Xe were briefly referred to. Recordings of normal individuals in seated position were illustrated, and the effect of gravity was explained. As cases of pulmonary hypertension, recordings of mitral stenosis, pulmonary embolism, and left to right intracardiac shunt were explained by diagrammatic presentation. Changes in the intrathoracic pressure differing according to the level of respiration were illustrated. As the clinical case, recordings of pneumoempyema were illustrated. As for the changes in the alveolar pressure, recordings of a case with narrow airway to the lower lobe due to left hilar tumor and a case of obstructive pulmonary disease were shown for explanation. On the relation of alveolar pressure to ventilation and blood stream, there is no more than presumption at present. Finally, the changes of alveolar pressure summarized by Nunn and a series of their effect were illustrated. (JA)

3324 X RAY AND NUCLEAR-MEDICINE FINDINGS IN BACTERIURIA. Raue, I.; Luschnitz, E.; Tauchnitz, C. Z. Gesam. Inn. Med. Ihre Grenzgeb.; 29: No. 16, 650-654(15 Aug 1974). (In German)

On 30 patients with symptomatic or lithopyelonephritis on the one hand and oligo- to asymptomatic bacteriuria on the other in 88% of the cases pyelonephritic changes in the intravenous urogram and in 73% of the cases pathological ING-findings were established. Though in the symptomatic group the severe disturbances were to be found more frequently, however, an asymptomatic bacteriuria, too, may be concomitant with already advanced pyelonephritic renal changes or functional disturbances. The concordance between pathological x-ray findings and pathological ING-findings exclusive of single kidneys was 90% for the symptomatic and 50% for the asymptomatic cases. Falsely negative ING-findings above all concerned patients with one kidney. Compared with the intravenous urogram the ING has the advantage that also improvements after successful antibacterial therapy are recognizable. (auth)

3325 EXAMPLES OF DEPARTMENTS FOR DIAGNOSIS AND THERAPY WITH UNSEALED SOURCES. pp 45-50 of Manual on Radiation Protection in Hospitals and General Practice. Volume 2. Unsealed Sources. Frost, D.; Jammet, H. (eds.). Geneva; World Health Organization (1975).

Radiation protection requirements for hospitals using unsealed radioactive sources and the problems associated with the administration, handling, and transportation of radionuclides are reviewed. The design, construction, and management of nuclear medicine departments are discussed. Methods are outlined for reducing the radiation exposure of patients, medical personnel, and the general public. Radiation monitoring, decontamination methods in the case of accidents, and procedures for handling cadavers with incorporated radionuclides are also discussed. (CH)

3326 UNILATERAL ABSENT PERFUSION OF THE LUNG. Tomsick, T. A.; Holder, L. E. (Cincinnati General Hospital). J. Am. Med. Assoc.; 234: No. 1, 89-90(6 Oct 1975).

Lung ^{131}I-albumin macroaggregate scintiscan findings and roentgenologic findings are discussed that led to the diagnosis of bronchogenic carcinoma in a patient with the absence of acute symptoms. (CH)

3327 SIMULTANEOUS DETERMINATION OF TESTOSTERONE, 5alpha-ANDROSTAN-17beta-OL-3-ONE, 5alpha-ANDROSTANE-3alpha,17beta-DIOL AND 5alpha-ANDROSTANE-3beta, 17beta-DIOL IN PLASMA OF ADULT MALE RABBITS BY RADIOIMMUNOASSAY. Schanbacher, B. D.; Ewing, L. L. (Johns Hopkins Univ., Baltimore). Endocrinology; 97: No. 4, 787-792(Oct 1975).

A simultaneous radioimmunoassay procedure for plasma testosterone (T), 5alpha-androstan-17beta-ol-3-one (DHT), 5alpha-androstane-3alpha,17beta-diol (3alpha ol), and 5alpha-androstan-3beta,17beta-diol (3beta ol) is described in this report. Peripheral plasma concentrations of T, DHT, 3alpha ol, and 3beta ol were 1.61 +- 0.26, 0.49 +- 0.15, 0.17 +- 0.03, and 0.24 +- 0.04 ng/ml, respectively, in adult male rabbits. In contrast, T, DHT, 3alpha ol, and 3beta ol peripheral plasma concentrations in dexamethasone-treated castrate rabbits were 0.07 +- 0.01, 0.02 +- 0.01, 0.07 +- 0.01, and 0.05 +- 0.01 ng/ml, respectively. These results represent the first simultaneous measurement of T, DHT, 3alpha ol, and 3beta ol in peripheral plasma of any male vertebrate. Moreover, we suggest that DHT, 3alpha ol, and 3beta ol represent the unidentified immunoreactive material found in peripheral plasma of male rabbits by Falvo and Naibandov. (auth)

3328 RADIOIMMUNOASSAY OF PLASMA RELAXIN LEVELS THROUGHOUT PREGNANCY AT PARTURITION IN THE PIG. Sherwood, O. D.; Chang, C. C.; Bevier, G. W.; Dziuk, P. J. (Univ. of Illinois, Urbana). Endocrinology; 97: No. 4, 834-837(Oct 1975).

Relaxin concentrations in peripheral plasma have been measured throughout pregnancy and immediately following parturition in the pig by radioimmunoassay. Gestation ranged from 114 to 117 days. Relaxin concentrations remained below 2 ng/ml during the first 100 days of pregnancy and then rose gradually to a mean of 11.9 ng/ml by 3 days before parturition. At this time, relaxin levels began to rise more rapidly and over the next 2 days increased to a mean concentration of 44.0 ng/ml by 30 h before parturition. Relaxin concentrations then increased sharply to a mean of 145.6 ng/ml by 14 h before parturition. This maximum was followed by a rapid decrease to a mean of 42.4 ng/ml by 2 h before parturition. At one day following parturition, relaxin levels were less than 1 ng/ml. (auth)

3329 SUPPRESSION OF SUPERPHOSPHATE-PHOSPHORUS FIXATION BY FARMYARD MANURE, 1. High Phosphorus Uptake From Superphosphate. Sharif, M.; Chaudhry, F. M.; Latif, A. (Nuclear Inst. for Agriculture and Biology, Lyallpur (Pakistan)). Soil Sci. Plant Nutr. (Tokyo); 20: No. 4, 387-393(Dec 1974).

Pot and field experiments were conducted on alkaline calcareous soils of Pakistan to determine the effect of premixing superphosphate (SUP) with farmyard manure (FYM) on the fraction of plant phosphorus derived from the ^{32}P labelled SUP (y value). Premixing (SUP with FYM) before their addition to soil, markedly increased the uptake of SUP-P by plants. The premixed treatment also increased crop yield on phosphorus deficient soil. Optimum quantity of FYM required was twice that of SUP. Higher quantities of FYM had no additional effect on phosphorus availability from SUP. The possible mechanism of this effect and the implications of these observations in phosphorus nutrition of plants have been discussed. (auth)

3330 PENETRATION OF ^{32}P-DIMETHOATE INTO ORGANOPHOSPHATE RESISTANT AND SUSCEPTIBLE CITRUS RED MITE, PANONYCHUS CITRI McGREGOR (ACARINA: TETRANYCHIDAE). Hirai, K.; Miyata, T.; Saito, T. (Nagoya Univ. (Japan). Faculty of Agriculture). Appl. Entomol. Zool.; 8: No. 3, 183-190(Sep 1973).

The penetration of ^{32}P-dimethoate into the mite body was investigated as part of a broad study attempting to clarify the mechanism of dimethoate resistance in the citrus red mite, Panonycus citri McGregor. Although there was no apparent difference in dimethoate penetration between the resistant and susceptible strains by topical application with a micrometer syringe without distinction of the solvents for dimethoate, an interstrain difference in penetration was observed by a spraying method. Sixty-two and 64% of sprayed dose penetrated the cuticle into the mite body of the susceptible strains, Wakayama and Ogi, while only 44 and 15% of sprayed dose penetrated into the body of the resistant strains, Shuku and Shizuoka, by the 9th hour following application. The difference in penetration rate of dimethoate is considered to be one of the factors involved in the mechanism of dimethoate resistance in the citrus red mites. (auth)

3331 GLUCOSE CATABOLISM DURING AGING AND DIFFERENTIATION IN HYPOCOTYLS OF PHASEOLUS MUNGO SEEDLINGS. Ashihara, H.; Komamine, A.; Shimokoriyama, M. (Tokyo Univ. (Japan). Faculty of Science). Shokubutsugaku Zasshi; 87: No. 1006, 121-131(Jun 1974).

Changes in activities of the glycolytic and pentose phosphate (PP) pathways in glucose catabolism in various parts of the hypocotyls obtained from 4-day-old etiolated Phaseolus mungo seedlings were investigated by measuring the inhibition rates of respiration by iodoacetate and malonate, and the release of $^{14}CO_2$ from [1-^{14}C]- and [6-^{14}C] glucose. The higher activity of the PP pathway in the immature part is attributable to larger amounts of NADP[H] and enzymes of the PP pathway. The greater contribution of the PP pathway to glucose catabolism in the aged part than in the intermediary part seems to result from a more active turnover of NADP and the relatively higher activity of the enzymes of the PP pathway than those of the glycolytic pathway. (auth)

3332 A KINETIC STUDY OF THE ASSIMILATION OF ^{15}N-LABELED AMMONIUM IN RICE SEEDLING ROOTS. Yoneyama, T.; Kumazawa, K. (Tokyo Univ. (Japan). Faculty of Agriculture). Plant Cell Physiol. (Kyoto); 15: No. 4, 655-661 (Aug 1974).

The pathway of ammonium nitrogen assimilation, its incorporation into amino acids and synthesis of protein was studied with the aid of nitrogen-15. The analysis of ^{15}N involves the use of optical emission spectrometry. Kinetic analysis of nitrogen assimilation by the roots indicates that glutamine and glutamic acid were the primary products of ammonium assimilation. Possibly some of the amino acids, such as aspartic acid and alanine received their amino nitrogen directly from free ammonia in the roots. Amino groups were transformed into other amino acids from these primary products, especially from glutamic acid through transamination. (auth)

3333 METABOLIC CHANGES IN THE RICE PLANT DURING INFESTATION BY THE BROWN PLANTHOPPER, NILAPARVATA LUGENS STAL (HEMIPTERA: DELPHACIDAE). Cagampang, G. B.; Pathak, M. D.; Juliano, B. O. (International Rice Research Inst., Los Banos (Philippines)). Appl. Entomol. Zool.; 9: No. 3, 174-184(Sep 1974).

The leaf blades of rice plants (Oryza sativa L. cv. Taichung Native 1) infested with adults of the brown planthopper, Nilaparvata lugens, declined in chlorophyll, moisture, soluble protein, and protease activity, but increased in level of free amino-N, and amino acid incorporation compared with leaf blades of uninfested plants. The leaf sheaths of the infested plants showed similar effects. They also had lower dry weight and level of sugars than leaf sheaths of uninfested plants. Heavy infestation resulted in over 30-fold increase in the levels of arginine, asparagine, lysine, proline, and tryptophan with a 6-fold increase in free amino acids of leaf blades. Increasingly severe planthopper damage to the plant was accompanied by decline in the rate of leucine-U-^{14}C uptake by the plant. Restriction of feeding site to either leaf blades or leaf sheaths resulted in localized damage. (auth)

3334 EARLY REPLICATING DNA IN HETEROCHROMATIN OF PLAGIOCHILA OVALIFOLIA (LIVERWORTS). Masubuchi, M. (Tokyo Metropolitan Research Inst. of Public Health, Tokyo (Japan)). Shokubutsugaku Zasshi; 87: No. 1007, 229-235(Sep 1974).

The timing of DNA replication of heterochromatin in male Plagiochila ovalifolia was investigated by the use of ^{3}H-thymidine autoradiography. The estimated duration of the mitotic cycle was as follows: S period, 19 hr; G_2 + prophase, 10 hr; G_1 + meta-, ana-, telophase, 5 hr; total mitotic cycle, 34 hr. The first appearance of silver grains over the chromosomes was observed at 8 hr after the beginning of pulse labelling at which time the silver grains were only over the euchromatic regions, not over the heterochromatic regions. This labelling pattern was also observed at 10 to 15 hr. The heterochromatic regions having more grains than the euchromatic regions were observed at 20 to 25 hr. These results show that the DNA of the heterochromatin of this species is replicated earlier than the euchromatin. (auth)

3335 STUDIES ON DEVELOPMENT AND DIFFERENTIATION OF MUSCLE, 6. Cytokinetic Analysis of Cell Proliferation by Using ^{3}H-Thymidine Autoradiography in Various Muscle Tissues of Chick Embryo. Kikuchi, T.; Nagatani, T.; Tamate, H. (Tohoku Univ., Sendai (Japan). Faculty of Agriculture). Tohoku J. Agric. Res.; 25: No. 1, 22-36(Sep 1974).

The main purpose of the present study is to analyze the cytokinetics of the presumptive myoblasts proliferating in various muscle tissues such as the M. complexus, the M. biceps femoris, and the M. pectoralis at the different embryonic days by using ^{3}H-thymidine autoradiographic techniques. The labeling index (LI), the mitotic index (MI), and the proliferation index (PI) in

these muscles began to decline after 9 days of incubation and showed a large difference in the pattern of decline between the M. complexus and the other muscles at 10, 12, and 13 days of incubation. During these developmental periods, the changes of these values in the M. complexus showed a more remarkable decline than the other muscles. The cytokinetic analysis of the presumptive myoblasts demonstrated that there was very little difference in the duration of the generation time and its component phases in various muscle species, but the length of the total mitotic cycle was prolonged progressively with the passing of the developmental stages. The lengthening of the generation time was mainly dependent upon the increase of the G_1-period of the mitotic cycle. Therefore, the reason why the LI, MI, and PI values of the M. complexus at 10, 12, and 13 days of incubation indicated lower values primarily depends upon a rapid decline in the percentage of the actively dividing myoblasts. It seemed reasonable to assume that the growth and the proliferation of the successive generation myotubes affected the cell fusion of the myogenic cells which wait for a chance for cell contacts and cell fusion. The mode of increase in the number of myotubes within the primordia of the primary muscle fascicles were discussed. (auth)

3336 FIXATION OF $^{14}CO_2$ IN THE DARK BY CUCUMBER LEAF INFECTED WITH THE CUCUMBER DOWNY MILDEW FUNGUS. Inaba, T.; Kajiwara, T. (National Inst. of Agricultural Sciences, Tokyo (Japan)). Nippon Shokubutsu Byori Gakkaiho; 40: No. 4, 295-298(Sep 1974). (In Japanese)

Fixation of $^{14}CO_2$ in the dark by cucumber leaf infected with the cucumber downy mildew fungus, Pseudoperonospora cubensis (Berk. et Curt.) Rostow., was examined, and compared with that in the natural sunlight condition. The radioactivity (cpm/10 mg dry weight) of ^{14}C fixed in lesions immediately after the exposure to $^{14}CO_2$ in the dark was 601 to 813. These figures were corresponded to 2.7 to 3.7 times as high as that in the healthy part of the same leaves. The radioactivity of ^{14}C in lesions decreased to 293 to 344 1 day after the treatment with $^{14}CO_2$. However, the radioactivity of ^{14}C fixed in lesions in the dark was extremely little as compared with that of ^{14}C fixed in lesions through the photosynthetic pathway in the natural condition (under the sunlight about 50,000 Lux). That is, the radioactivity (cpm/10 mg dry weight) of ^{14}C fixed in the dark was 93, while that of in the natural condition was 38,216. The ^{14}C fixed in lesions both under the natural and dark conditions was incorporated into conidia on infected leaves. There existed, however, large differences between the natural and dark conditions in the amount of ^{14}C incorporated into the conidia. They were 439,139 in the natural condition and 1,464 in the dark, respectively. (auth)

3337 ABSORPTION TEST WITH SIMULTANEOUS ORAL ADMINISTRATION OF VITAMIN B_{12} BY A DUAL ISOTOPE TRACER TECHNIQUE. Assessment of its Diagnostic Value. Uchiyama, Y.; Okuda, K. (Chiba Univ. (Japan). School of Medicine). Bitamin; 48: No. 12, 565-573(Dec 1974). (In Japanese)

A vitamin B_{12} absorption test by simultaneous administration of human gastric juice (intrinsic factor)-bound ^{57}Co-B_{12} and free ^{58}Co-B_{12} was carried out in 10 control subjects, five patients with pernicious anemia, one with total gastrectomy, and four with malabsorption syndrome. The test is equivalent to two Schilling tests with and without added intrinsic factor, but it is done in one test with the use of two isotopes. Radioactivities of two labels were measured in plasma and urine with time, and in 24 hour urine. Maximum radioactivities were found 8 to 10 hours after oral administration. The 24 hour urinary excretion in the control was $17.4 \pm 7.3\%$ for ^{58}Co-B_{12} and $17.9 \pm 6.0\%$ for ^{57}Co-B_{12}, with a $^{57}Co/^{58}Co$ ratio of close to unity. In malabsorption syndrome, urinary excretion of both were extremely low but the ratio was almost unity. In pernicious anemia and in subjects with total gastrectomy, urinary excretion of ^{58}Co-B_{12} was $2.1 \pm 1.1\%$, and $^{57}Co/^{58}Co$ was 6.2 ± 5.1. Thus, this dual isotope method is of diagnostic value similar to Schilling test done on two occasions. However, it was also found that some of the gastric juice bound B_{12} is exchanged in the digestive tract with free B_{12} and, that to minimize such errors, it is recommended that two doses be given with a two hour interval. In patients in whom complete urinary collection is difficult, or the flushing dose is unwanted, measurement of 8 hour plasma radioactivity may serve the same purpose. (auth)

3338 STUDIES ON THE METABOLISM OF CHLOROPHENOLS IN FISH, 1. Absorption and Excretion of PCP by Goldfish. Kobayashi, K. (Kyushu Univ., Fukuoka (Japan). Faculty of Agriculture); Akitake, H. Nippon Suisan Gakkaishi; 41: No. 1, 87-92 (Jan 1975).

A study has been made of the absorption and excretion of pentachlorophenol (PCP) by goldfish, Carassius auratus. Three concentrations of PCP (0, 1, 0.2, and 0.4 ppm) were investigated, and it was found that the amount accumulated by the fish increased with time. The concentration factor after exposure for 120 hr in 0.1 ppm PCP was approximately 1000. Maximum accumulation was observed in fish exposed to 0.2 ppm and showed a value of 116 μg-PCP/g-body weight. PCP absorbed by the fish was rapidly excreted by active elimination. After 10 hr in PCP-free water only half of the original amount remained. When fish which had been previously exposed to ^{14}C-labeled PCP were transferred to water containing non-radioactive PCP, both excretion into and accumulation of PCP from the medium were observed, i.e. the concentration in the fish increased by the amount expected from absorption minus that expected from excretion until it reached a concentration of about 100 μg-PCP/g-body weight at which time mortality occurred. It was also shown that most of the PCP found in the fish had not undergone decomposition. (auth)

3339 STUDIES ON THE METABOLISM OF CHLOROPHENOLS IN FISH, 2. Turnover of Absorbed PCP in Goldfish. Kobayashi, K. (Kyushu Univ., Fukuoka (Japan). Faculty of Agriculture); Akitake, H. Nippon Suisan Gakkaishi; 41: No. 1, 93-99 (Jan 1975).

A study has been made regarding the turnover of absorbed pentachlorophenol (PCP) in various organs of goldfish, Carassius auratus, during absorption in a PCP-medium (0.2ppm), its subsequent excretion in running water, and also its decomposition using ^{14}C labeled PCP. PCP absorbed by fish from the medium was accumulated in various organs, especially the gall bladder. The biliary concentration of PCP reached a value of 539 μg/g after a 24-hr exposure, and displayed a further increase even after fish had been transferred to clean, running water for 24 hr, whereas a decrease was observed in all other organs examined. PCP in the gall bladder eventually reached a level of 1,077 μg/g, corresponding to a concentration factor of 5,400, which accounted for 41% of the total PCP detected in fish after transfer to running water for 24 hr. Some decomposition of PCP in fish was confirmed by a slight increase in the specific activity found in the gall bladder. It is probable that a large proportion of the PCP and ^{14}C found in the gall bladder had been transferred from the hepatopancreas after detoxification by conjugation or decomposition. The characteristic accumulation of PCP in the gall bladder indicates that fish can dispose of PCP by active elimination such as conjugation and decomposition, although BRODIE et al. (1962) have concluded that fish dispose of drugs by passive diffusion through the gills. (auth)

3340 IMMUNOCHEMICAL PROPERTIES OF THE SPECIFIC ANTI-4-AZOQUINOLINE 1-OXIDE ANTIBODY. Nakashima, S.; Mazaki, M.; Sugimura, K. (Toyama Univ. (Japan). Faculty of Pharmaceutical Sciences). J. Biochem. (Tokyo); 74: No. 3, 539-544(Sep 1973).

Specific anti-4-azoquinoline 1-oxide antibodies were prepared by the use of immunoadsorbent. The average association constants with ^{14}C-4-nitroquinoline 1-oxide (4NQ0) were in the range of 1 to 2×10^5 L/M. The relative affinities for 4-aminoquinoline 1-oxide (4AQ0) and 4-aminoquinoline (4AQ) were 0.061 and 0.024, respectively, taking that of 4NQ as 1. It is suggested that the anti-hapten antibody-Chromagel conjugates might serve as a means for the isolation of some cross-reacting metabolites of 4NQ0. (auth)

3341 BIOTRANSFORMATION OF 3-(3',5'-DICHLOROPHENYL)-5,5-DIMETHYL OXAZOLIDINE-2,4-DIONE, 1. Metabolism in the Rats. Sumida, S.; Hisada, Y.; Kometani, A.; Miyamoto, J. (Sumitomo Chemical Co. Ltd., Osaka (Japan)). Agric. Biol. Chem. (Tokyo); 37: No. 9, 2127-2136(Sep 1973).

Using 3-(3',5'-dichlorophenyl)-5,5-dimethyloxazolidine-2,4-dione (DDOD) labeled with ^{14}C or ^3H, absorption, excretion, and tissue distribution in male Wistar rats were studied, and metabolites excreted were identified. At the dosage rates of 100, 300, 1000, and 3000 mg/kg, the maximum excretion of orally administered radioactivity occurred within 24 hr. Increase in the dosage rate was paralleled by decrease in the proportion of urinary elimination. Essentially all the radioactivity was excreted in 2 weeks. DDOD level was generally low in most tissues. Adipose tissue contained higher radioactivity compared with others. Most of the urinary metabolites identified were characterized by hydroxylation at the 4' position of the benzene ring moiety and hydrolytic or oxidative modification of the oxazolidine ring portion. (auth)

3342 EFFECTS OF PROTEIN DEFICIENCY ON SERUM ALBUMIN-SYNTHESIZING ACTIVITY OF RAT LIVER. With Special Reference to the Presence of Transcriptional Controls. Kido, H.; Shimazu, Y.; Ueki, M.; Ogata, K. (Niigata Univ. (Japan). School of Medicine). J. Biochem. (Tokyo); 74: No. 4, 747-756(Oct 1973).

Employing livers from rats fed a protein-free diet for two weeks, the effects of protein deficiency on serum albumin (SA)-synthesizing activity were investigated. While the ^{14}C-leucine

incorporation into the total protein of the postmitochondrial (S_{12}) or ribosomal (R) fraction of the protein-deficient did not decrease as compared with that of the normal, the incorporation into the SA fraction decreased significantly in the former. Only a part of the decreased activity resulted from calorie deficiency in the former since the incorporation into the SA fraction of control calorie-deficient livers was significantly higher than that of the former, although lower than that of the latter. Furthermore, 2 hr after refeeding the diet specific for each group, the SA-synthesizing activity of the former was significantly lower than that of the latter, although the activity increased in both after refeeding. The time course of the effect of refeeding complete diet to the protein-deficient rats on the incorporation into the various liver fractions was examined. The incorporations into the S_{12} and R fractions increased rapidly after refeeding, reaching maximal values at 12 and 2 hr, respectively. Although the incorporation into the SA fraction also increased rapidly up to 12 hr, it continued to increase gradually up to 120 hr. Total protein-deficient liver polysomes showed a lower activity in SA synthesis than those of the normal. The pattern of sucrose gradient centrifugation showed that polysomes heavier than the hexamer decreased in the former. Membrane-bound polysomes also decreased in the former. Polysomes containing nascent albumin decreased significantly in the protein-deficient as compared with the normal. Experiments with a rabbit-reticulocyte lysate system showed that the template activity for SA synthesis of the total postmitochondrial RNA from the protein-deficient was lower than that of the normal. These results may indicate that the low activity for SA synthesis in the protein-deficiency may partly arise from a decrease of specific RNA for SA. (auth)

3343 ISOLATION OF ESCHERICHIA COLI MUTANTS WITH TEMPERATURE-SENSITIVE FORMATION OF PHOSPHATIDYLETHANOLAMINE. Ohta, Akinori; Okonogi, K.; Shibuya, I.; Maruo, B. (Tokyo Univ. (Japan). Inst. of Applied Microbiology). J. Gen. Appl. Microbiol. (Tokyo); 20: No. 1, 21-32(Feb 1974).

From Escherichia coli CS101, mutants with temperature-sensitive formation of phosphatidylethanolamine (PE) have been isolated by a combination of ^{3}H suicide concentration from the mutagenized cells which incorporated L-serine [3-^{3}H] and a survey of phospholipid synthesis by a direct ion-exchange paper chromatography. Among 306 temperature-sensitive growth mutants, 38 strains were found defective in optimal formation of PE at 42°. Changes in lipid synthesis in these mutants accompanied by abnormalities of growth and morphology have been described. Among them, OS294, the most thermosensitive in PE formation, was further characterized. Upon temperature shift from 27° to 42° of this strain, the formation of PE stopped almost immediately and completely, while that of phosphatidylglycerol (PG) continued and that of cardiolipin (CL) was significantly stimulated. The usefulness of these mutants defective in single lipid synthesis for understanding the possible roles played by individual lipids in cell physiology has been discussed. (auth)

3344 STUDIES ON PHOTOSYNTHESIS AND TRANSLOCATION OF PHOTOSYNTHATE IN MULBERRY TREE, 3. Translocation of ^{14}C-Photosynthetic Product from Leaves of Different Ages. Satoh, M. (Sericultural Experiment Station, Tokyo (Japan)). Nippon Sakumotsu Gakkai Kiji; 43: No. 1, 99-104(Mar 1974).

Translocation of photosynthetic product was investigated in young mulberry plants using a radioisotope ^{14}C as a tracer. The results obtained will be summarized as follows: (1) most of photosynthetic product translocated from the fed leaf in 3 to 4 days after the administration, remaining 20-30% of photosynthetic product in the fed leaf. ^{14}C-photosynthetic product was mainly distributed to stem, stump or root, but scarcely translocated to mature leaves; (2) distribution rate was relatively high to stem tip from upper leaf, while rate to stump or root was high from lower leaf; (3) when the whole shoot was fed with $^{14}CO_2$, the specific activity of leaf in successive leaves immediately after the administration resembled the variation of photosynthetic activity in successive leaves measured by infrared gas analizer. Plants with longer days after planting distributed larger proportion of photosynthetic product to stump or root. (auth)

3345 UPTAKE OF ^{14}C-GLYCINE INTO THE DEVELOPING CHICK EMBRYO, 2. Investigation of ^{14}C-Glycine Incorporation by Means of Autoradiography. Hasegawa, H.; Tanaka, H. (Aichi Univ. of Education, Kariya (Japan)). Aichi Kyoiku Daigaku Kenkyu Hokoku, Shizen Kagaku; No. 23, 53-57(Mar 1974). (In Japanese)

In order to study the pathway of amino acids to chick embryo following to the previous report, 0.1 ml of ^{14}C-glycine sodium chloride solution (2389000 dpm/ml) was added to albumen of fertilized egg and then incubated at 38 ± 0.5°C for 5 days. The autoradiograph was made with the chick embryo. Intense radioactivities were recognized at telencephalon, diencephalon, mesencephalon, metencephalon, spinal nerve and cartilage tissue induced from notochord. And then the radioactivities were also intensely found at heart, liver, and mesonephros in the region of viscera. Moreover the activities were recognized at epidermis and muscle slightly. This fact indicated that ^{14}C-glycine added in the albumen was incorporated into the chick embryo as follows: albumen → yolk → embryo. (auth)

3346 STUDIES ON ACYL DONORS FOR PLASMA CHOLESTEROL ESTERIFICATION. Triglyceride Fatty Acids in Rats in Vivo. Sugano, M. (Kyushu Univ., Fukuoka (Japan). Faculty of Agriculture). J. Biochem. (Tokyo); 75: No. 3, 619-625(Mar 1974).

The rate of utilization of triglyceride fatty acids in cholesterol esterification in rat plasma was studied in vivo using glyceryl tri [1-^{14}C] palmitate, oleate, and linoleate under conditions where the initial rate of utilization could be measured. Labelled triglycerides coated on Celite 545 were shaken with rat serum at 0-2°C for 22-24 hr and the centrifugal supernatant was injected intravenously into rats. Blood was collected at timed intervals from 15 to 240 min after the dose. These triglyceride fatty acids were apparently utilized for the esterification in vivo, the extent of which was considerably greater with unsaturated triglycerides than saturated. The major route for the utilization of triglyceride fatty acids as acyl donors for esterification in vivo appeared to proceed via intermolecular transfer of the fatty acids from triglyceride to phospholipids, possibly to the 2-position of lecithin. The possible significance of other lipid component(s) as a donor of palmitic acid for the reaction was suggested. (auth)

3347 EFFECT OF DIETARY PHENYLALANINE AND NITROGEN LEVELS ON THE OVERALL METABOLIC FATE OF LABELED PHENYLALANINE, TYROSINE AND VALINE IN THE ADULT ROOSTER. Ishibashi, T.; Kametaka, M. (Tokyo Univ. (Japan). Faculty of Agriculture). Nippon Chikusan Gakkai-Ho; 45: No. 3, 165-171(Mar 1974)

To illustrate the reason why the rooster maintains nitrogen equilibrium on the Phe-free diet, the effect of dietary Phe and nitrogen levels on the overall degradation rate of Phe-^{14}C was compared with that of Tyr- and Val-^{14}C in the rooster with an artificial anus. When Tyr- or Val-^{14}C was injected, recovery percentage of dosed ^{14}C in the urine and expired air was not affected by the dietary Phe level. When Phe-^{14}C was injected, recovery percentage of dosed ^{14}C in the urine was not affected by the dietary Phe level, but that in the expired air for the Phe-free diet was significantly low compared with that for the Phe containing diet. These results suggest that the overall metabolic fate of Phe in the rooster on the Phe-free diet is heavily biased in favor of conservation of Phe. (auth)

3348 EFFECT OF LEVELS AND KINDS OF NITROGEN AND ENERGY SOURCES ON THE UTILIZATION OF NON-PROTEIN NITROGEN COMPOUNDS BY RUMEN MICROORGANISMS IN VITRO. Takahashi, F.; Kametaka, M.; Kandatsu, M. (Tokyo Univ. (Japan). Faculty of Agriculture). Nippon Chikusan Gakkai-Ho; 45: No. 3, 157-164(Mar 1974).

In a series of in vitro experiments, some factors influencing the utilization of non-protein nitrogen (NPN) by rumen microorganisms were studied. Media used in this study consisted of 10 ml of strained rumen fluid, 30 ml of the mineral solution, and various nitrogen and energy sources. The results obtained are summarized below. (1) The amount of microbial protein and deoxyribonucleic acid (DNA) increased with the time of incubation and doubled during 6 hr of incubation. The concentration of ammonia had a maximum value at the 1st hour of incubation and then gradually decreased. (2) The rate of incorporation of ammonium sulfate-^{15}N into microbial nucleic acid-N was faster than that into microbial protein-N in the earlier part of the incubation period. (3) No marked differences were found among any of the NPN compounds tested as nitrogen sources except for biuret. Biuret was less ($P < 0.01$) available than other NPN compounds such as urea for the utilization of NPN. (4) Starch was more effective in promoting the utilization of NPN than other energy sources tested such as glucose and cellulose powder. (5) The greatest amount of microbial protein was synthesized when both urea and amino acids were supplied to the medium as nitrogen sources. (auth)

3349 METABOLISM OF CONTINUOUS THREE WEEKS ADMINISTERED ^{14}C-PYRIDAFENTHION, O, O-DIETHYL-O-(3-OXO-2-PHENYL-2H-PYRIDAZINE-6-YL) PHOSPHOROTHIOATE, IN MOUSE. Udagawa, T.; Miyata, T.; Saito, T. (Nagoya Univ. (Japan). Faculty of Agriculture). Bochu Kagaku; 39: No. 1, 15-18(Feb 1974). (In Japanese)

^{14}C-pyridafenthion, O,O-diethyl-O-(3-oxo-2-phenyl-2H-pyridazine-6-yl) phosphorothioate, (20 mg/kg) was orally applied to the mouse for a three week period, and the excretion of ^{14}C-pyrida-

fenthion to the urine and feces and the accumulation in internal organs were compared with those of the mouse applied with ^{14}C-pyridafenthion (20 mg/kg) once. The rate of excretion of the insecticide to the urine and feces was not affected by the continuous application. There were no differences in the rate of excretion of the insecticide to the urine and feces and the accumulation in internal organs after finishing application of the insecticide, and it was thought that ^{14}C-pyridafenthion applied to the mouse was rapidly excreted to the urine as water soluble metabolites. The metabolites of the insecticides administered continuously were investigated in the urine. The composition of the metabolites was slightly varied between urine samples collected at one day and 21 days after starting continuous administration, which may be due to the age difference of the mouse. (auth)

3350 RAPID INCORPORATION OF ^{15}N INTO AMIDE NITROGEN OF RICE SEEDLING ROOTS FROM $(^{15}NH_4)_2SO_4$, 1. Role of Glutamine in the Processes of Absorbing and Assimilating Nitrogen in Plants. Arima, Y. (Tokyo Univ. (Japan). Faculty of Agriculture). Nippon Dojo Hiryogaku Zasshi; 45: No. 11, 509-512(Nov 1974). (In Japanese)

$(^{15}NH_4)_2SO_4$ was absorbed into rice seedlings, and the incorporation of ^{15}N was investigated. It is considered that amide compounds in rice seedlings contain the initial assimilated products directly connected to the absorption of ammoniac nitrogen as their main component, and they are synthesized actively in roots. The amide compounds synthesized in roots transfer to the parts above ground, and it is important as the transferring mode of nitrogen at the time of the absorption of ammoniac nitrogen. The synthesis of amide compounds in the parts above ground is far less than that in roots, and it is considered that almost all the amidic nitrogen existing in the parts above ground is that transferred from roots. The amount of ammoniac nitrogen in roots is in proportion to the ammonium concentration in cultivating ground rather than to absorbing period, while that of amidic nitrogen is in proportion to the absorbing period and to absorbed amount rather than to the ammonium concentration in cultivating ground. (JA)

3351 THE USE OF ^{15}N AS THE BIOLOGICAL SCIENCE TRACER METHOD, 2. Mitsui, S. Kagaku To Seibutsu; 12: No. 12, 838-844(Dec 1974). (In Japanese)

The development of the use of ^{15}N in Japan is described. At the early stage of ^{15}N measurement, mass spectrometers were used in the fields of agriculture, stock forming, basic medicine, clinics, fishery, and oceanography. Recently, optical spectrometers have been introduced in order to measure the extremely small quantity of ^{15}N below 1 μg. This method has been used in such an example as the measurement of ^{15}N concentration in the amino acids separated by thin layer chromatography. The future of ^{15}N utilization is viewed to be the safe tracer for biological science. (JA)

3352 CLINICAL STUDIES ON TUMOR SCINTIGRAPHY WITH ^{67}Ga-CITRATE. Baba, Hiroyasu; Koga, Y.; Hirabayashi, S.; Kitahara, T.; Munechika, H. (Showa Univ., Tokyo (Japan). School of Medicine). Showa Igakkai Zasshi; 33: No. 6, 737-743(Dec 1973). (In Japanese)

It is the present situation that there is no suitable substance which is very effectively accumulated in tumor (tumor affinity agent). ^{67}Ga-citrate is, however, relatively accumulated in tumor tissues, and it has been extensively used clinically. Our present report dealt with the investigation of scintigraphy with ^{67}Ga-citrate, for several kinds of malignant and benign tumors. Scintigrams of 116 patients with tumor were observed at 48 hours after ^{67}Ga-citrate 1.5 to 2.0 mCi injection. Eighty-two percent of lung cancers, 71 percent of malignant lymphomas, and 59 percent of laryngeal carcinomas showed positive findings. As localization of the tumors are concerned, most of them in the head and neck and the chest showed positive findings. However, owing probably to accumulation of the nuclide in intestine and bone, negative findings were frequently the results in malignant lymphoma in abdomen. ^{67}Ga-citrate-scintigraphy should be useful for detecting tumor in the head and neck and the chest, and for determining clinical stage of malignant lymphoma. And it could be contributable to radiation therapy or surgical operation and following up of the disease in size and extent. Whole-body scintigraphy could find metastases with no physical findings. (auth)

3353 ON THE INCORPORATION OF ^{75}Se-SELENOMETHIONINE INTO THE ACID-SOLUBLE AND PROTEIN FRACTIONS OF MOUSE PANCREATIC CELLS. Goto, Rensuke; Tezuka, M.; Ishigami, K.; Tamemasa, O. (Shizuoka Coll. of Pharmacy (Japan)). Kaku Igaku; 11: No. 4, 453-463(Aug 1974). (In Japanese).

We worked out for a comparative study of ^{75}Se-Met incorporation into acid-soluble and protein fractions of mouse pancreatic and liver cells, in vitro and in vivo. In vitro, the radioactivity of ^{75}Se-Met incorporated into the acid-soluble fraction of normal mouse pancreatic cells was 1.5–2.5 times higher than that of protein fraction within 30 min., and the ratio of the liver cells was 2-9 within 90 min. The total incorporation (acid-soluble fraction + protein fraction) into pancreatic cells was about 3 times higher, through the incubation period within 90 min., than into liver cells. Fasting of mice had no effect on the incorporation. On the other hand, in vivo, the radioactivity of ^{75}Se-Met in the acid-soluble fraction of normal mouse pancreatic cells was about one third of that in the protein fraction through the period after injection. And in order to find correlations among amino acids pool size in the acid-soluble fraction, their contents in the protein fraction and their incorporation into both fractions, amino acid analysis of both fractions of pancreatic and liver cells was carried out by an amino acid analyser. Consequently, the pool size of methionine, a mother substance of selenomethionine, was considerably small compared to that of other amino acids. Phenylalanine, a mother compound of iodo-phenylalanines investigated as a pancreas-scanning agent, also had a small pool size. These results suggested that there might be a correlation between amino acids pool size and their incorporation into acid-soluble fraction of pancreatic cells. (auth)

3354 ACCUMULATION OF RADIOACTIVE ISOTOPE IN CHRONIC SUBDURAL HEMATOMA. Kwak, Ryungchan; Aoki, A.; Suzuki, J.; Nakamura, M. (Tohoku Univ., Sendai (Japan). School of Medicine). No To Shinkei; 26: No. 9, 907-917(Sep 1974). (In Japanese).

The present study was made to investigate accumulation of radioactive isotope (R. I.) in the 44 cases of chronic subdural hematoma. As the R. I., ^{203}Hg-chlormerodrin, ^{197}Hg-chlormerodrin, ^{113m}In-EDTA, ^{131}I-RISA and ^{51}Cr-RBC (red blood cell) were used. After intravenous injection of R. I. all cases were operated and R. I. counts of hematoma, outer and inner membrane were measured with scintillation counter. The R. I. accumulation of hematoma, outer and inner membrane showed that $^{203}Hg = ^{197}Hg = ^{113m}In > RISA > ^{51}Cr$-RBC. The ratios of the positive accumulation of R. I. were 100% in ^{203}Hg, ^{197}Hg, and ^{113m}In, 96.3% in RISA and 36.8% in ^{51}Cr-RBC in hematoma. The average of the ratio of R. I. count of hematoma for that of peripheral blood was 33.7% in ^{203}Hg, 36.0% in ^{197}Hg, 35.1% in ^{113m}In, 7.9% in RISA and 3.6% in ^{51}Cr. As for the time of sampling after administration of R. I. in hematoma no significant difference was observed with ^{203}Hg. But RISA and ^{51}Cr-RBC of the 24-hours group were more than that of the 4-hours group. In the outer and inner membrane, the R. I. accumulation of the 4-hours group was more than that of 24-hours group in all R. I. On the symptom of chronic subdural hematoma, no significance was observed in ^{203}Hg and RISA in hematoma. But when the symptom reached to its peak or symptom was heavy, accumulation of ^{51}Cr became much more than that the symptom was light. Any fixed tendencies were not given in both the outer and inner membrane in all R. I. On the term from the onset of head injury to the R. I. administration the accumulation of ^{51}Cr was as much as the term was short in hematoma. The outer membrane showed no fixed tendencies, while the R. I. accumulation in inner membrane was as much as the term was long. On the term from the onset of chronic subdural hematoma to the R. I. adminstration, the accumulation of ^{51}Cr was as much as the term was short in hematoma. The accumulation of ^{203}Hg and RISA were as much as the term was long in outer and inner membrane. (auth)

3355 STUDIES ON NON PROTEIN-BOUND CORTISOL WITH EQUILIBRIUM DIALYSIS. Hashimoto, K.; Asaoka, K.; Ofuji, T. (Okayama Univ. (Japan). School of Medicine). Kaku Igaku; 11: No. 5, 531-539(Oct 1974). (In Japanese).

Dynamics of non protein-bound cortisol were investigated with simple equilibrium dialysis. One ml plasma was pipetted into a Visking tube with a diameter of 8/32'' and dialyzed to equilibrium in a glass tube containing 1.5 ml phosphate buffer at 37°C for 16 hours. Tracer dose of ^{14}C-cortisol (0.002 μCi, 0.014 μg) was added inside or outside a cellophane tube. Following results were obtained. Same percentage of unbound cortisol was obtained regardless of whether ^{14}C-cortisol was added inside or outside the tube. Unbound percentage of plasma cortisol in 14 normal subjects was 6.6 ± 2.2 (SD) % and non protein-bound cortisol was 0.63 ± 0.28 (SD) μg/dl. Non protein-bound cortisol was increased after injection of α^{1-24} ACTH, decreased after administration of dexamethasone, increased in patients with Cushing's syndrome and decreased in patients with adrenal insufficiency. In patients treated with 7.5 mg diethylstilbestrol (DES: synthetic estrogen) for 3 days, plasma total cortisol was higher than in control group, whereas unbound percentage was decreased. Diurnal variation of unbound percentage of cortisol was not found, but similar variation to total cortisol was found in non protein-bound cortisol. In rapid ACTH test, increase of total cortisol was greater in DES treated group than in control group. Non protein-bound cortisol was also increased in DES treated group. Increase of corti-

costeroid binding globulin-bound cortisol (CBG) was most significant, although albumin-bound cortisol was also increased in DES treated group. So that, not only increase of CBG but any other factors appear to be concerned in significant increase of total cortisol at rapid ACTH test in DES treated group. (auth)

3356 SIMULTANEOUS DETERMINATION OF BOTH PLASMA RENIN ACTIVITY AND PLASMA ANGIOTENSIN II BY RADIOIMMUNOASSAY OF ANGIOTENSIN II. Fukuchi, S. (Tohoku Univ., Sendai (Japan). School of Medicine). Tohoku Igaku Zasshi; 87: No. 1, 55-61(Jun 1974). (In Japanese).

For the determination of plasma renin activity (PRA), plasma was incubated at 37°C for 14 hours at pH 5.5 for the generation of angiotensin I, which was then converted to angiotensin II at 37°C for 6 hours at pH 7.5. The generated angiotensin II was measured by radioimmunoassay of angiotensin II. Plasma angiotensin II (PAL) in arterial blood was also determined by radioimmunoassay after the purification by Dowex 50W-X4 column. In normal subjects, PRA and PAL showed 1.67 ± 0.65 ng/ml and 53 ± 29 pg/ml, respectively. Both PRA and PAL were low in primary aldosteronism, high in renovascular hypertension, and normal in essential hypertension and chronic glomerulonephritis. A positive correlation was observed between values of PRA obtained by bioassay and those by radioimmunoassay. Observed changes in PAL were accompanied by directionally similar changes in PRA. No significant difference of PRA was found between samples obtained from venous and arterial blood. The arterial values of PAL were slightly higher than the venous values. In summary, the measurement of PRA was found to be more useful means than that of arterial PAL for the diagnosis of various kinds of hypertension, especially primary aldosteronism and renovascular hypertension. (auth)

3357 A NUMERICAL ANALYSIS ON PHOTO-SCINTIGRAPHIC OUTLINE PATTERN OF LIVER WITH Au-198 COLLOID. Konishi, K.; Okuyama, T.; Suzuki, S. (Tokyo Medical and Dental Univ. (Japan). School of Medicine). Nippon Igaku Hoshasen Gakkai Zasshi; 34: No. 10, 752-762(Oct 1974). (In Japanese).

The study is concerned with one of the steps to the objective evaluation on hepatic scintigram, using electric computer. In polar coordinates, of which origin is arbitrarily placed at the midpoint between the right and left lobes, having an origin in the center of the liver scintigram, the contour of the liver is showed by radius r to be a function of angle θ. The function of equation is expanded in a Fourier series. Each Fourier coefficient contains a character of the pattern, and four parameters are induced from these Fourier coefficients. They are informations on the size of liver (Ao), on the grade of deviation from the standard pattern (V), on the feature of left lobe (L) and on the feature of right lobe (R). The above analysis is applied to the photo-scintigrams or liver in a series of 21 cases. The points plotted on Ao-V plane in each case can be divided into three groups, which are well correlated to the clinical diagnosis of normal, cirrhotic and tumor-containing liver, respectively. (auth)

3358 BONE SCINTIGRAPHY WITH ^{99m}Tc-LABELED PYROPHOSPHATE. Hamamoto, K.; Yamamoto, I.; Morita, R.; Sakamoto, T.; Mori, T. (Kyoto Univ. (Japan). Faculty of Medicine). Kaku Igaku; 11: No. 6, 637-645(Dec 1974). (In Japanese).

Scintigraphy of bone and joint with ^{99m}Tc-labeled pyrophosphate and scintillation camera or whole body scanner was performed for 97 cases with primary bone tumors, metastatic bone tumors, and other diseases of bone and joint. In 13 cases with primary bone tumors, positive results were obtained with exception of two of five cases with fibrous cortical defect whose results were negative. Any abnormal finding was not demonstrated on the X-ray films in five of 18 cases with metastatic bone tumors whose scintigraphies were positive. In some cases under chemotherapy, hormone therapy or radiation therapy, metastatic bone lesions were not demonstrated on scintigrams. All eight cases with multiple myeloma showed rather decreased accumulation of ^{99m}Tc-pyrophosphate. The labeling procedures of pyrophosphate with ^{99m}Tc were simple and this preparation could be considered stable by descending paper chromatography in 85% methanol and clinical studies. It was concluded that scintigraphy with this material was useful to demonstrate the metastatic lesions in the bone and to determine the site and extent of the tumors. (auth)

3359 PATHOPHYSIOLOGY OF BRONCHIAL ASTHMA, WITH SPECIAL REFERENCE TO THE QUANTITATIVE OBSERVATION OF THE REGIONAL DISTRIBUTION OF PULMONARY ARTERIAL BLOOD FLOW DURING ASTHMATIC ATTACK AND ATTACK-FREE INTERVAL. Yamada, T. (Nihon Univ., Tokyo. School of Medicine). Kaku Igaku; 11: No. 6, 665-683(Dec 1974). (In Japanese).

Sixty-four asthmatic patients were examined for regional pulmonary blood flow during asthmatic attack and attack-free period. The regional distribution of blood flow was measured by pulmonary arterial perfusion scanning with ^{131}I-MAA. The quantitative regional blood flow was examined by using scinticamera with a computer data analysis system. The relationship between regional blood flow and lung function was examined with arterial blood-gas tensions, and following results were obtained. (1) On lung scan of asthmatics, remarkable disorder of regional blood distribution was seen during asthmatic attack but the phenomenon was mostly reversible. During the attack-free interval, there was a slight decrease in regional blood flow. On the relationship between the defects in scintigram and lung function or the blood-gas tension, forced expiratory volume in one second decreased with increasing defects in the scintigram. There was no significant relationship among the others. (2) The reversible phenomenon of decreased regional blood flow during asthmatic attack and its increase during the attack-free interval was observed. Patients with intractable asthma showed an intense decrease in regional blood flow during asthmatic attack and the decrease was also marked during the attack-free interval, suggesting the presence of organic changes in the bronchopulmonary system. In general, there was a significant correlation between the severity of attack and the decrease of regional pulmonary arterial blood flow. (3) There was decrease of regional blood flow in cases with forced expiratory volume in one second under 1,000 ml, forced expiratory volume in one second% under 55%, R_R over 4.1 cm $H_2O/1/sec$, %VC under 60%. With respect to the blood-gas tension, the cases with PaO_2 below 80mm Hg showed a decrease in regional blood flow but there was no distinct correlation between the decrease of regional blood flow with $PaCO_2$ and HCO_3-. (auth)

3360 A RADIOIMMUNOASSAY OF PROGESTERONE. Serum Progesterone Concentrations after Synthetic LH-releasing Hormone (LH-RH) Administrations. Furuhasi, N.; Oohasi, I.; Abe, T.; Nakagawa, K.; Hirano, M. (Tohoku Univ., Sendai (Japan). School of Medicine). Nippon Funin Gakkai Zasshi; 20: No. 1, 41-46(Jan 1975). (In Japanese).

A method is described for determination of progesterone in peripheral venous serum using an antiserum to progesterone-3-caroxymethyl-oxime-bovin serum albumin (BSA) and without chromatography. The lowest level of progesterone which may be determined was 20 pg/ml serum. The concentration (mean ± S. D., pg/ml) in the follicular phase was 518.5 ± 85.7, in the early luteal phase was 1087.5 ± 204.3 and in the late luteal phase was 891.5 ± 131.9 in the women. The water blank of this radioimmunoassay was 6 ± 2.2 (pg/ml, mean ± S.D., N = 6) and the recovery rate of progesterone-^{3}H was about 80%. The serum FSH and LH were determined by a heterologous double-antibody radioimmunoassay. Then, responses of serum FSH, LH and progesterone to a synthetic LH-releasing hormone (LH-RH) were examined in 6 women. In some women, serum progesterone was released after from 15 min. to 30 min., synchronized with elevation of LH after administration of LH-RH, but there was no distinct correlation between the concentration of FSH, LH and progesterone in serum. (auth)

3361 DYNAMICS OF PLASMA PROGESTERONE IN NONGRAVID WOMEN AND IN PREGNANCY ESTIMATED BY RADIOIMMUNOASSAY. Mukai, H. (Nihon Univ., Tokyo. School of Medicine). Nichidai Igaku Zasshi; 33: No. 11-12, 935-948(Dec 1974). (In Japanese).

To help clarify some of the problems involving Progesterone (P), we have developed a highly specific, sensitive antibody to P and using this antibody, measured the P concentration in the peripheral blood of non-gravid women and women in early pregnancy. We used P-3-oxime BSA our antigen and injected domestic rabbits and obtained the following results. Three months after the initial inoculation of the antigen, the antiserum showed reactivity at 2×10^4 dilutions, and at seven months showed reactivity at 4×10^4 dilutions. The rate of antiserum cross reactivity was 38.5% against 5α-pregnanedione, 5.6% with 20α-hydroxy progesterone, 5.2% with 11 deoxy-corticosterone and 1.2% with pregnenolone. Cross reactions with other steroids could not be detected. The sensitivity of the method is 10 pg, and requires less than 0.1 ml of serum which is extracted with ether and radioimmunoassayed. The results of this method contrasted with samples separated chromatographically show a close correlation ($r = 0.987$, $P > 0.001$). The accuracy of this method is high with an inter and intraassay variance of 8.4% and 9.5% respectively. In women with normal menstrual cycles, serum P during proliferatory phase was 0.56 ± 0.25 ng/ml (Ave, values ± standard deviation omitted), 1.75 ± 0.30 ng/ml during the ovulatory phase, and 7.63 ± 2.53ng/ml during the ovulatory phase. Serum P concentrations show a dramatic increase with the inception of pregnancy, but during the ninth week of gestation show a sharp drop, thereafter followed by a rapid increase, until at term, serum P

concentrations are 156.9 ± 26.9 ng/ml or roughly 20 times that of the secretory (luteal) phase. The drop in serum P levels observed in the ninth week of gestation is believed to be caused by the interplacental shift of P production. (auth)

3362 COMPARISON BETWEEN A NEW KIDNEY SCANNING AGENT (^{99m}Tc-DIMERCAPTOSUCCINIC ACID) AND OTHER KIDNEY SCANNING AGENTS. Ando, Atsushi; Hiraki, T. (Kanazawa Univ. (Japan). School of Paramedicine); Aburano, T.; Hisada, K.; Ando, I. Radioisotopes (Tokyo); 24: No. 1, 46-51 (Jan 1975). (In Japanese).

It was reported in USA recently that dimercaptosuccinate had been labeled with ^{99m}Tc-pertechnetate for imaging renal cortical morphology and its in vivo kinetics resemble that of ^{203}Hg-chlormerodrin. To compare ^{99m}Tc-dimercaptosuccinic acid (^{99m}Tc-DMSA) with conventional kidney scanning agents (^{203}Hg-chlormerodrin and ^{203}Hg-salyrgan), their in vivo distributions were investigated after intravenous administration of these agents to rats. Following these experiments, clinical study was performed in patients to evaluate the practical usefulness of ^{99m}Tc-DMSA. ^{99m}Tc-DMSA was intravenously injected to the rats, and at 1, 3, 6 and 24 hours after the administration these rats were sacrificed and the uptake rate of this compound in the various organs was determined. Also in vivo distributions of ^{203}Hg-chlormerodrin and ^{203}Hg-salygen were examined. In clinical study, two subjects (25-year-old female with hyperthyroidism and 28-year-old female with thyroid cancer) were selected from among volunteers. Two mCi of ^{99m}Tc-DSMA was administered intravenously to each patient. Scintiphotos were obtained at 5, 10, 30, 60, 120 and 240 minutes after injection with a Nuclear-Chicago Pho/Gamma HP camera. The uptake rate of ^{99m}Tc-DMSA in rat kidney was 45.5% (of administered dose) and this value was slowly increased with a lapse of time. On the other hand, these values of ^{203}Hg-chlormerodrin were 71.1% at one hour, and 86.2% at 3 hours after the administration, and after that, these values were slowly decreased. The uptake rate of ^{203}Hg-salyrgan into the rat kidney was 43.9% at one hour after the administration and ^{203}Hg-salyrgan taken into the kidneys was rapidly excreted from the kidneys. In clinical study, kidneys were delineated clearly one hour after intravenous administration and this image was not varied with time. From the above-described results, it is thought that ^{99m}Tc-DMSA is an excellent kidney scanning agent and may replace the use of organoradiomercurial agents in the study of renal cortical morphology. (auth)

3363 THE MEASUREMENT OF URINARY TESTOSTERONE BY RADIOIMMUNOASSAY. Osada, T.; Inoue, T.; Hirano, A.; Tanaka, K.; Osawa, K. (Sei Marianna Medical Univ., Kanagawa (Japan)). Sei Marianna Ika Daigaku Zasshi.; 2: No. 3, 252-258 (Sep 1974). (In Japanese).

A radioimmunoassay of urinary testosterone was described for the use in clinical practice. Urine volumes of 2 μl from men and 20 μl from women containing ^{3}H-testosterone glucoronide as internal standards were hydrolyzed with sulphuric acid at 100°C. After the samples were extracted with ether, the extracts were placed in microcolumns of Sephadex LH-20 with the solvent system of hexane: benzene: methanol (80 : 10 : 10). Following elution, the dried purified extracts of the testosterone fraction were incubated with antiserum to testosterone-3-oxime-bovine serum albumin (supplied by Department of Pharmacological Research Teikoku Hormone Mfg. Co. Ltd.) and ^{3}H-testosterone. The unbound steroid was removed by precipitation with ammonium sulfate and the supernatant containing the bound ^{3}H-testosterone was counted by a liquid scintillation spectrometer. The accuracy, precision and sensitivity of the method were satisfactory. (auth)

3364 CLINICAL SIGNIFICANCE OF SMOOTHED ^{67}Ga-CHEST SCINTIGRAMS. Machida, K.; Yasukochi, H.; Ohshima, M.; Sugawara, T.; Kumura, F. (Tokyo Univ. (Japan). Faculty of Medicine). Kaku Igaku; 12: No. 1, 13-23(Feb 1975). (In Japanese).

As a method for obtaining more diagnostic information from ^{67}Ga scintigrams of the chest disease, we processed them by means of thirteen points smoothing by TOSBAC-40 computer. We concluded that the smoothed scintigram is much better than those of the non-smoothed one for detecting diseased areas, but in order to improve the display further, it seems necessary to use special printing characters which are suitable for human eyes to recognize the scintigram pattern. It is also important to set both the maximum and the minimum count-levels in a pixel of the digital scintigram in order to more easily make a diagnosis from the image. In view of the symmetric distribution of ^{67}Ga in the chest, we showed the automatic calculation of integral counts of the left and right areas. The ratio between the counts would be useful indices in the automatic diagnosis of ^{67}Ga chest scintigrams. (auth)

3365 A NON-CHROMATOGRAPHIC RADIOIMMUNOASSAY FOR PLASMA DEXAMETHASONE. Lee, Ying-Shih; Ohsawa, N. (Tokyo Univ. (Japan). Faculty of Medicine). Endocrinol. Jpn.; 21: No. 6, 481-484(Dec 1974).

A nonchromatographic radioimmunoassay for plasma dexamethasone is presented. Corticosteroid binding protein (CGB) was used to bind endogeneous steroids, and free dexamethasone was adsorbed with Florisil. The purified sample was assayed by using an antiserum to dexamethasone-21-BSA. The plasma blank was less than 10 pg. When 0.1 ml of plasma containing 20 ng of cortisol was measured, the blank could not be differentiated from charcoal treated plasma. The ^{3}H-dexamethasone recovery from purification procedures was 33.2 ± 4.4%. Accuracy and precision were satisfactory. Plasma dexamethasone concentrations in patients receiving dexamethasone administration are also reported. (auth)

3366 SOLID-PHASE RADIOIMMUNOASSAY OF TESTOSTERONE IN BLOOD. Hosoki, H.; Ofuji, M. (Okayama Univ. (Japan). School of Medicine). Igaku No Ayumi; 89: No. 3, 97-98 (Apr 1974). (In Japanese).

Aimed at the simultaneous measurement of massive samples, the solid-phase RIA of blood testosterone (T) using a plastic disposable microtiter tray (DMT) with 96 0.2 ml cups was attempted. Extraction was performed by the method of Yoshimi et al except for adding a tracer amount of ^{3}H-T to each sample, using 0.1 ml of the male plasma and 1 ml of the female plasma. For the preparation of the solid phase, antisera of 5000-fold dilution were added to the plastic DMT, and after coating for 24 hours at room temperature, the antisera were discarded and the content was preserved at room temperature. The sample or the standard was dissolved in the buffer containing ^{3}H-T, 0.2 ml of which was transferred to the antiserum coated DMT for incubation at room temperature. Twenty-four hours later, the reaction solution was discarded and the remainder was transferred to a counting vial, to which the toluene scintillator was added for complete dissolution of cups. Then, dmp was measured with the fluid scintillation counter. The blood T value was 687 ± 269 (SD) mμg/dl (N = 31) for normal males and 46 ± 16 (SD) mμg/dl (N = 14) for normal females. ^{3}H-T was put in the coated cup for incubation, and the count of the bound showed a coefficient of variability of 2.6% (N = 10), the variation due to the cup itself being negligible. No precipitate appearing in the counting vial, the present method was thought to be superior to the saturated ammonium sulfate method and the DCC method. (JA)

3367 PS TEST IN APPLICATION OF ^{75}Se-SELENOMETHIONINE. Sawabu, N.; Hirose, S.; Takada, A.; Takeuchi, J. (Kanazawa Univ. (Japan). School of Medicine). Nippon Rinsho; 32: No. 4, 779-787(Apr 1974). (In Japanese).

The combination of ^{75}Se-selenomethionine (^{75}Se-sm) with the PS test was examined basically and clinically. Pancreozymin (Pz) and Secretin (Sc) were injected intravenously and continuously into five mature dogs subjected to laparotomy, and fractional sampling of the pancreatic juice and bile was performed every 30 minutes over 5 and a half hours. Intravenous injection of ^{75}Se-sm was given 30 minutes after the start of the intravenous injection of Pz and Sc. The total radioactivity and the output of protein radioactivity of the pancreatic juice, and the comparative protein radioactivity per total protein and amylase activity unit of the pancreatic juice reached a plateau 2 hours after the intravenous injection of ^{75}Se-sm. The output of total radioactivity into the pancreatic juice and the protein bound radioactivity on and after the 2nd hour of the intravenous injection of ^{75}Se-sm were 2 to 3 times and 5 to 6 times those of the bile. It was thought to be appropriate to perform the PS test after the lapse of 2 hours after the intravenous injection of ^{75}Se-sm when there is little effect of the mixture of the bile. Clinically, the PS test was conducted on 38 patients chiefly of pancreatic or biliary disease at 2 hours and 20 minutes after the intravenous injection of ^{75}Se-sm. Changes of the total radioactivity and output of protein radioactivity were similar to the amylase secretion pattern. Both outputs showed a definitely significant correlation with the amylase output. The output of radioactivity in 80 minutes of the PS test discriminated clearly between a group with more than two abnormal factors of the present PS test and a normal group, but not a group with one abnormal factor. The present method is advantageous over the existing PS tests, (1) since it allows judgement of abnormal enzyme secretion by the measurement of the output of radioactivity and produces more stable values because of the simpler judgement of radioactivity than that of enzyme measurement and (2) since the combination of pancreatic scanning possible allows simultaneous morphologic diagnosis and functional diagnosis from scintigram. (JA)

3368 RADIOIMMUNOASSAY OF HYPOTHALAMUS HORMONE. With Reference to Gonadotropin-Releasing Hormone.

Tamada, T.; Araki, S. (Jichi Medical School, Tochigi (Japan). School of Medicine). Rinsho Kagaku; 10: No. 9, 1072-1076(Sep 1974). (In Japanese).

Radioimmunoassay (RIA) of gonadotropin-releasing hormone (Gn-RH), and our technique and the fundamental data were discussed. The antigenicity of Gn-RH prepared for RIA, and the specificity of its antibody were mentioned. In our improved technique, Sephadex G-25 was used for separating free ^{125}I from ^{125}I-Gn-RH. For fundamental determination, anti-Gn-RH-BSA serum was employed. The sensitivity of Gn-RH was 6.25 to 12.5 pg/ml; and was significantly distinguished. When 25 to 500 pg/ml of Gn-RH was added to male monkey serum, and 125 to 2,500 pg/50 mg tissue to rat cerebral cortex, the recovering rate showed high correlation. As to precision, examination of 20 samples of acidic extracts from the rat hypothalamus revealed variable coefficient of 5.5 per cent by interassay and 8.3 per cent by intraassay. The effects of anti-Gn-RH-BSA serum and anti-Gn-RH-charcoal serum were compared to each other with the same materials except for the serum. The standard curves of both serum paralleled closely to each other, and the inhibition curve in radioimmunoassay of acidic extracts of rat hypothalamic region using Gn-RH-charcoal serum also paralleled to its standard curve. Our recent experiments revealed the Gn-RH level in the peripheral blood of monkeys, rats and human beings as less than 2.5 pg/ml, and that in the hypothalamic region of mature female rats as 2 to 8 ng. (JA)

3369 FAT ABSORPTION TEST BY USE OF RI. Hosoda, S.; Nakagawa, M. (Kyoto Prefectural Univ. of Medicine (Japan)). Rinsho Hoshasen; 19: No. 6, 419-425(Jun 1974). (In Japanese).

The fat digestion and absorption test by use of RI is qualified as a method for labeled balance study, with a very simple technique compared with chemical determination. The commercially available ^{131}I-triolein poses no particular problem as the hot meal used in the ^{131}I-triolein fat digestion and absorption test performed clinically. The cold meal should have the same chemical composition as that of the hot meal. The desirable amount of cold meal for tolerance is the upper limit of the physiologic intake of meals. Well-type NaI scintillation counter is used for the measurement of radioactivity. Various devices are made for measurements of massive samples, and measurement errors can be reduced by taking the ratio of a sample to the standard measured under the same conditions. The digestion and absorption test by means of RI centered around the ^{131}I-triolein fat digestion and absorption test has considerably spread. However, sufficient consideration is not given to the test meal, method of performance, and method of measurement in some of the reports encountered today in spite of the authors' description of their necessity in 1963. Attention is called here again, and simultaneously, it is desirable to standardize the method of this test for popularization. (JA)

3370 SCINTISCANNING OF THE CISTERNA. Kusakabe, K. (Tokyo Women's Medical Coll. (Japan)). Gendai No Shinryo; 16: No. 5, 659-668(May 1974). (In Japanese).

The method of examination of the kinetics of the cerebrospinal fluid in the cisterna by scintiscanning using ^{131}I, ^{99m}Tc, and ^{169}Yb as tracers was outlined and was explained with clinical cases. The radioactive medical supplies, instruments, and method used for the examination, the circulation of the cerebrospinal fluid, and the normal distribution of ^{169}Yb-DTPA were outlined individually. As clinical application, scintiscanning was performed with the lapse of time in cases of spinal cord tumor, hydrocephalus with normal cerebrospinal pressure, obstructive hydrocephalus due to pineal tumor and cerebrospinal rhinorrhea for explanation. Cisterna scintigraphy is thought to be the only method for observing the natural behavior of the cerebrospinal fluid and finding morphologically abnormalities of the cerebrospinal lumen. (JA)

3371 STATUS AND PERSPECTIVES IN LYMPHOGRAPHY. Irino, S. (Okayama Univ. (Japan). School of Medicine). Mayakkangaku; 14: No. 6, 495-500(Sep 1974). (In Japanese).

Status and perspectives in lymphography were discussed with reference to about 1,000 cases of our personal experiences. Clinical utilization of lymphography ranged widely from diagnosing method to treatment. Among therapeutic utilization, endolymphatic radiotherapy in which radioisotope was infused directly into the lymphatic system was mentioned. ^{131}I-Lipiodol was infused to the dogs in the lymphatic vessels of the dorsal site of the feet to the dogs in the lymphatic vessels of the dorsal site of the feet and the percentage of localized radioactivities in the organs showed high, predominant and long-standing uptake in the lymph nodes. This fact was identified in cases of human being by linear scanning, plane scanning, and imaging with scinticamera. When the mass of the lymph nodes before and after infusing ^{131}I-Lipiodol was measured by planimeter in 10 cases, the effect curves on tumor shortening rate of all the cases showed remarkable shortening of tumors identifying that endolymphatic radiotherapy was very useful for treating malignant lymphoma. In lymphatic scintigraphy, radioisotopes as ^{198}Au-colloid which was frequently used in the past were injected subcutaneously, but recently intravenous administration of ^{67}Ga-malate and ^{67}Ga-citrate was developed, which provided the clearer picture of the lymph nodes, although the deep-situated lymph nodes could not, or hardly could be visualized, and the diagnosing ability of scintigraphy was inferior to lymphography. Further studies on better radioisotopic imaging of lymphatic systems was expected. (JA)

3372 A RADIOIMMUNOASSAY USING N-TERMINAL OF SYNTHETIC PARATHORMONE OF CATTLE. Kanai, N.; Takizawa, C.; Ohhata, M.; Fujita, T.; Yoshikawa, M. (Tokyo Univ. (Japan). Faculty of Medicine). Kotsu Taisha; 8: No. 1, 39-41 (Oct 1974). (In Japanese).

The assays of C-terminal and N-terminal of the parathormone of cattle were done parallel to each other, using antibodies of guinea-pig. GP-100, which mainly responds to C-terminal, and GP-M, which responds to N-terminal as well as C-terminal, were used as antibodies and the N-terminal parathormone of cattle (1-34) was labeled with ^{125}I in the conventional way (1-84). The ratio of N-terminal parathormone to C-terminal parathormone was larger in primary hyperparathyroidism than in secondary parathyroidism, and in the latter it seemed that the C-terminal fragment increased relatively in the blood. (JA)

3373 STUDIES ON DISTRIBUTION OF SEVERAL TRITIUM LABELLED SUBSTANCES IN THE PANCREAS. Tezuka, M.; Goshima, R.; Fujisawa, S.; Ishigami, K.; Tamemasa, O. (Shizuoka Coll. of Pharmacy (Japan)). Kaku Igaku; 11: No. 4, 503-507(Aug 1974). (In Japanese).

As one of the basic studies to develop new scanning medium for the pancreas, ^{3}H-labeled 2-methyl-8-hydroxyquinoline, one of the experimental inducing substances, was given orally to mice, and the radioactivities in the pancreas and liver were measured with passage of time. On the other hand, ^{3}H-labelled Rutin, which had been reported to be detected by fluoromicroscopy, and ^{3}H-diglycerin-ether were given orally or intravenously, and the distribution of radioactivities was measured in the pancreas, liver, and in other several organs. As the results, these substances showed poor specific concentration to the pancreas, and revealed to be practically less useful as the parent compound for new scanning medium of the pancreas. (JA)

3374 TRANSPLACENTAL PERMEABILITY OF THE ANTIBODY TO PATERNAL ANTIGEN. Saji, Fumitaka; Nakamuro, K.; Ogawa, M.; Wakao, T.; Negoro, T. (Osaka Univ. (Japan). Faculty of Medicine). Nippon Sanka Fujinka Gakkai Zasshi; 26: No. 12, 1323-1332(Dec 1974). (In Japanese).

The manner in which the antibody against paternal histocompatibility antigen existing in the blood of pregnant women transmitted to fetus through the placenta was experimentally examined using pregnant rats and highly purified antibody, and the following results were obtained: ^{131}I-labeled γ-globulin obtained from normal rats was administered to pregnant rats, and the radioactivity in the maternal blood showed semi-logarithmic graph and attenuated almost linearly with its half life being 24 hours. On the other hand, transmitted γ-globulin into fetus reached the peak 16 to 24 hours after injection and diminished slowly and slightly after plateau. Purified antibody against paternal histocompatibility antigen adhered to the placenta by immunological reaction. This fact was confirmed by the result that eluted antibody which had been adhered to the placenta revealed immunological characteristic of strong affinity to paternal histocompatibility antigen. However, antibody did not bind to the placenta 1 hour after injection of antibody suggesting that paternal histocompatibility antigen in the placenta seemed to exist considerably apart from the maternal blood. Purified antigen administered to the maternal blood transmitted to fetus through the placenta as same amount as that of γ-globulin obtained from normal rats. (JA)

3375 ^{131}I-19-IODOCHOLESTEROL ADRENAL SCANNING IN PRIMARY ALDOSTERONISM. Kubo, Atsushi; Kobayashi, T.; Isobe, Y.; Dokiya, T. (Keio Univ., Tokyo (Japan). School of Medicine); Hiramatsu, K. Rinsho Hoshasen; 20: No. 1, 31-38 (Jan 1975). (In Japanese).

Adrenal scanning was done in 24 patients, seven of primary aldosteronism, one of so-called idiopathic aldosteronism, 13 of essential hypertension and others. A tracer dose of 1 mCi of ^{131}I-19-iodocholesterol was injected intravenously and as a rule, scanning was done at 8 days after the administration. In addition, each adrenal region is isolated as a region of interest by recording the image of the adrenal regions on the oscilloscope of scinticamera, and right-to-left adrenal uptake ratio of ^{131}I-19-iodocholesterol was determined. In normal adrenals, right-to-left uptake ratio ranged from 1.05 to 1.60 and averaged in 1.37 ± 0.18, while in primary aldosteronism it ranged from 2.11 to 6.32 and was significantly higher than that of normal adrenals. Adrenal scan

accurately localized the tumor in all seven patients with primary aldosteronism. On the contrary, selective adrenal venography showed the tumor in three of the seven patients. In one patient with a 0.9 × 1.2 × 1.2 cm cortical adenoma demonstrated by adrenal scan, venography did not disclose the lesion. There was no correlation between right-to-left uptake ratio and the size of adenoma in primary aldosteronism. The reliability, the greater safety, and simplicity of adrenal scanning suggests that it should be used as a screening test before venography when primary aldosteronism is strongly suggested by endocrinological examinations. (JA)

3376 STUDY ON IRON-METABOLISM IN CHILDREN USING DOUBLE LABELLING OF ^{51}Cr AND ^{59}Fe, 1. Iron-Metabolism in Normal Children. Kobayashi, M. (Nippon Medical School, Tokyo). Nippon Shonika Gakkai Zasshi; 78: No. 10, 641-645(Oct 1974). (In Japanese).

The erythrocytes and plasma of children who were recovering from various diseases, excluding hematological diseases, were labelled with ^{51}Cr and ^{59}Fe. Ten cases which showed no abnormality in the peripheral blood consisted of 8 boys and 2 girls from 1 1/12-year-old to 13-year-old. The life span of red cell by Ashby technique 1/2 (AST 1/2), the circulatory blood volume (CBV), plasma-iron disappearance (PID), red cell-iron utility (RCIU), plasma-iron turn-over rate (PITR), and red cell-iron turn-over rate (RCITR) were examined and the following results were obtained: By the ^{51}Cr method, the AST 1/2 averaged 24.5 + 5.3 days while it averaged 31.4 ± 16.1 days by ^{59}Fe method. The CBV averaged 76.9 ± 10.2 ml/kg. The PID averaged 29.9 ± 9.0 minutes. The RCIU averaged 83.1 ± 18.0%. The PITR averaged 1.61 ± 0.89 mg/day/kg. The RCITR averaged 1.27 + 0.61 mg/day/kg. By the ferrokinetics analysis using the double labeling method, the fluctuations of each value were slightly larger than those of ^{59}Fe used singly. However, the fluctuation of the AST 1/2 was smaller, and this method was considered to be reliable than that with the single use of ^{59}Fe in the clinical evaluation. For elucidating the mechanism of anemia occurrence, the necessity of simultaneous determination of production and destruction of the red cell was suggested. PID was greatly varied by blood collection time. (JA)

3377 IRON ABSORPTION TEST BY WHOLE BODY COUNTER IN NEWBORN INFANTS OF LOW BIRTH WEIGHT. Watanabe, T. (Nagasaki Univ. (Japan). School of Medicine). Nippon Shonika Gakkai Zasshi; 78: No. 10, 654-662(Oct 1974). (In Japanese).

In order to observe iron absorption in premature infants, nasal administration of ^{59}Fe and measurement of the rates of iron absorption by Whole Body Counter were made upon 44 premature infants, with an age range from 13 days to four months. The mean iron absorption rate in premature infants during 3 weeks of life was 4.8%, 8.8% from 4 to 6 weeks of age, 15.4% from 7 to 9 weeks of age, and 24.9% in later premature infants. As a result, it revealed that iron absorption was increasing with growth of age. There was no significant difference in iron absorption rate in premature infants less than 6 weeks old, between birth weights, and no relationship between iron absorption rate and the value of serum iron. Premature infants absorb iron to a great degree during 7 to 9 weeks of life when some of them may have early anemia, and there is the inverse correlation between iron absorption and serum iron. (JA)

3378 SUBTRACTION SCANNING OF LIVER METASTASES WITH ^{67}Ga AND ^{99m}Tc. Erjavec, M.; Movrin, T.; Snajder, J. (Jozef Stefan Inst., Ljubljana, Yugoslavia). J. Nucl. Biol. Med.; 19: No. 2, 53-57(1975).

In order to obtain positive images of liver metastases, an off-line computer-assisted dual-analyser scintigraphic method was developed using ^{99m}Tc colloid to label the liver tissue and ^{67}Ga citrate to label both the liver and the malignant tissue. Subtraction of the simultaneously recorded counts of the two radionuclides gave positive images over structures concentrating more radiogallium than colloid. Of 95 patients where the liver condition was appraised by other means, subtraction scanning afforded correct diagnosis in 85 patients. The suggested method seems to be of value for clarifying equivocal conventional scans and ruling out malignancy in cases in which scan abnormalities are attributable to benign liver conditions. The method is probably of little help in well differentiated malignant tumors. (auth)

3379 ^{99m}Tc-GLUCONATE COMPLEX FOR KIDNEY SCANNING. De Filippi, P. G. (Inst. of Oncology, Turin); D'Onofrio, M.; Pretti, O.; Villa, M. J. Nucl. Biol. Med.; 19: No. 2, 58-64(1975).

The authors report their experience concerning a new ^{99m}Tc-labelled complex for renal scintigraphy. Chemical studies are reported that optimize and simplify the labelling procedure, which is carried out by direct addition of a pertechnetate solution to the freeze-dried tin-calcium gluconate: the yield is higher than 95%. The final product has been in vivo characterized on rats and mice to evaluate the tissue distribution and to determine the acute toxicity. Clinical trials on 86 patients with different renal pathologies are reported. (auth)

3380 EARLY EFFECTS OF CALCITONIN ON URINARY EXCRETION OF CALCIUM AND ^{47}Ca IN PAGET'S DISEASE. Gennari, C.; Vattimo, A. (Univ. of Siena, Italy). J. Nucl. Biol. Med.; 19: No. 2, 73-79(1975).

In Paget's disease patients given ^{47}Ca intravenously 5 to 7 hours previously, an intravenous infusion of 135 MRC units of salmon synthetic calcitonin resulted in an immediate increase of urinary excretion of calcium, radiocalcium and urinary specific activity of ^{47}Ca, simultaneous to the initial increase in plasma ^{47}Ca radioactivity and decrease of ^{47}Ca radioactive counts from bone. These data are compatible with an early mechanism of action of calcitonin on bone cells producing a shift of calcium to the circulation. (auth)

3381 RADIOIMMUNOASSAY FOR THYROXINE IN UNEXTRACTED SERUM. Filetti, S.; Galbiati, A.; Trimarchi, F.; Vigneri, R. (Univ., Catania, Italy). J. Nucl. Biol. Med.; 19: No. 2, 86-93(1975).

A radioimmunoassay for the measurement of thyroxine in small volumes of unextracted serum (0.025 ml) is presented. ANS (400 mcg/tube) was used to inhibit the TBG interference on T_4 binding to antibody, and dextran-coated charcoal (8 ng/tube) to separate bound from free labelled T_4. The present T_4 (RIA) procedure is more sensitive, precise and accurate than the T_4 (D) technique. In addition, it allows for the contemporaneous processing of a larger number of samples and, due to the wide range of the standard curve, it permits the direct measurement of T_4 in the range 1 - 32 mcg/dl. Finally, T_4 (RIA) behavior is described in several clinical states and after various pharmacological treatments. (auth)

3382 EFFECTS OF PLASMA PROTEINS ON THE RADIOIMMUNOASSAY OF TRIIODOTHYRONINE. Malvano, R.; Galbiati, A.; Zucchelli, G. C. (Consiglio Nazionale delle Ricerche, Pisa, Italy). J. Nucl. Biol. Med.; 19: No 2, 94-104 (1975).

The effects of T_3-interacting proteins on the quality of direct radioimmunoassay of plasma T_3 were investigated. For this study, merthiolate was used to partially inhibit the plasma proteins, and their residual binding ability was compensated for by using proteins as standard diluent. The influence of the proteins competing with antibodies on the sensitivity of the assay and on the accuracy of results was evaluated by varying a number of experimental factors, such as the method of separation of free from bound fraction (charcoal-dextran, gel equilibration), the individual antiserum, the concentration ratio antiserum-plasma, and the standard diluent (deprived plasma, albumin). Using the charcoal method, the combined effects of inhibitor and compensation for sample proteins proved adequate for reliable clinical measurements. Nevertheless, the choice of the protein solution to be used as a standard diluent was found to be of striking importance as far as accuracy is concerned. (auth)

3383 UNEVEN DEPOSITION OF MINIMICROSPHERES IN PATIENTS WITH OBSTRUCTIVE LUNG DISEASE. Santolicandro, A.; Fornai, E.; Marini, C.; Palla, A.; Solfanelli, S.; Giuntini, C. (Consiglio Nazionale delle Ricerche, Pisa, Italy). J. Nucl. Biol. Med.; 19: No. 2, 112-120(1975).

A method of lung scanning based on inhalation of nebulized albumin minimicrospheres (average diameter 0.85 micron) labelled with ^{99m}Tc is described. Results in patients with chronic obstructive lung disease suggest that the images of lung deposition of the minimicrospheres obtained with a large field scinticamera are very sensitive to disclose abnormalities in ventilatory dynamics. In particular, in patients with prevailing signs of chronic bronchitis, circumscribed zones of high particles deposition are interspersed with zones of scanty deposition. It is suggested that some regions of elevated deposition represent zones of hyperventilation since they are sometimes located at the periphery of the lung, accumulate activity from the start of inhalation, and are not cleared of radioactivity several hours after ending the nebulization. (auth)

3384 MICRORADIOIMMUNOASSAY FOR ANTIBODIES TO TUMOR-ASSOCIATED ANTIGENS. Huang, J.C.C. (Univ. of Manitoba, Winnipeg); Berczi, I.; Froese, G.; Tsay, H. M.; Sehon, A. H. J. Natl. Cancer Inst.; 55: No. 4, 879-886(Oct 1975).

A versatile microradioimmunoassay for the detection of antibodies to tumor-associated and other tissue antigens was described. The method involved: the preparation of solid-phase antigen with cultured (already adhered) or non-cultured cells

(sedimented by centrifugation) fixed to Micro-Test plates with neutral buffered formaldehyde or absolute methanol; the incubation of the antigen with test or control sera; and the incubation of the antigen with radioiodinated antiglobulin antibody. The nonspecific background of radioactivity was reduced to an acceptable level by the fixed cells being precoated in the wells with 0.5 percent bovine serum albumin in phosphate-buffered saline which was also used for the dilution of sera and labeled antiglobulin antibody. Tumor cells in primary cultures gave a high background, as compared to long-term cultures, which was due to the presence of immunoglobulins (most likely tumor-specific antibody). The specific antibody response to a syngeneic mouse tumor was demonstrated by this technique. (auth)

3385 MEASUREMENT OF SERUM FERRITIN BY RADIOIMMUNOASSAY: RESULTS IN NORMAL INDIVIDUALS AND PATIENTS WITH BREAST CANCER. Marcus, D. M.; Zinberg, N. J. Natl. Cancer Inst.; 55: No. 4, 791-795(Oct 1975).

Ferritins are iron-containing proteins found in normal tissues; they increase in concentration in many tumors and the blood of tumor-bearing individuals. Ee utilized a double-antibody radioimmunoassay for measurement of serum ferritin and defined the upper limit of normal as 146 ng/ml for women (mean 34 ng/ml) and 193 ng/ml for men (mean 93 ng/ml). Serum ferritin levels exceeded these limits in preoperative sera of 41 percent of women with mammary carcinoma (mean 199 ng/ml) and in 67 percent of women with locally recurrent or metastatic mammary carcinoma (mean 671 ng/ml). Individuals with hepatic inflammatory states are known to have high serum ferritin, and ferritin was increased in 43 percent of patients with hepatitis or cirrhosis (mean 364 ng/ml) and in 13 percent of patients with ulcerative colitis or gastroduodenal ulcers (mean 106 ng/ml). Measurement of serum ferritin may be useful in evaluation of patients with breast cancer and in monitoring their response to therapy. (auth)

3386 NUCLEAR MEDICINE AND ULTRASOUND: CORRELATION IN DIAGNOSIS OF DISEASE OF LIVER AND BILIARY TRACT. Lomonaco, A.; Kline, P.; Halpern, S.; Leopold, G. (Univ. of California, San Diego). Semin. Nucl. Med.; 5: No. 4, 307-324(Oct 1975).

Even though the radiocolloid scan is non-specific it will be approximately 70 to 80 percent accurate in predicting the presence or absence of liver disease and somewhat less accurate than that in making statements as to the specific type of disease. This compares well with other modalities. The ability of nuclear medicine techniques to provide a correct diagnosis is improved when additional isotopic techniques such as hepatic blood flow studies and ^{131}I-rose bengal and ^{67}Ga scanning are performed. Ultrasound scanning is also nonspecific. To date, the major application of ultrasound in the study of the liver has been in deciphering puzzling contour abnormalities seen on nuclear medicine scans and in demonstrating fluid-filled abnormalities. Its usefulness in diffuse and solid focal lesions has been less dramatic. More recently, however, the development of gray scale has necessitated a reevaluation of the technique. Gray scale demonstrates a large number of intrahepatic interfaces that were previously invisible, and it has already been shown to demonstrate focal disorders such as metastasis more easily than the non-gray-scale method. It can also demonstrate dilated biliary radicals, the gallbladder, and gallstones. In addition, while routinely studying the liver one can evaluate diaphragmatic motion and various retroperitoneal structures such as the pancreas, lymph nodes, and abdominal vascular structures. (auth)

3387 ULTRASONIC AND RADIONUCLIDE SCANNING IN PANCREATIC DISEASE. Kahn, P. C. (Tufts–New England Medical Center, Boston). Semin. Nucl. Med.; 5: No. 4, 325-338(Oct 1975).

Ultrasonic examination of the pancreas is rendered difficult by the echogenic characteristics of the organ, by its depth, by the overlying gas, and by bony structures and anatomic variations. The reintroduction of gray-scale imaging promises to simplify the technique and expand its usefulness. The ^{75}Se-I-selenomethionine scan is a reliable test when performed after effective pancreatic stimulation with a scintillation camera that permits the angulation required to separate pancreas from liver. Gallium-67-citrate may be important for both mapping inflammatory processes and imaging some tumors. Retrograde pancreatography has developed into a rather reliable and sensitive method of visualizing pancreatic duct abnormalities. Angiography remains the most reliable technique for finding small lesions, while computerized axial tomography appears a promising modality in the near future. In acute pancreatitis, gallium scanning may find a place alongside plain films, GI series, and echography. Chronic pancreatitis appears best studied by pancreatography, possibly with selenomethionine scanning as a function study and echography to find associated mass lesions. Pseudocysts are most easily located by ultrasound examination. Screening for pancreatic carcinoma is done most effectively with selenomethionine scanning when the index of suspicion is low and with pancreatography or arteriography when it is high. Echography is useful for localization for aspiration biopsy and for sequential evaluation of therapeutic response. Islet-cell tumors are best found by angiographic studies. (auth)

3388 COMBINED USE OF ULTRASOUND AND NUCLEAR MEDICINE TECHNIQUES IN KIDNEY DISEASE. Morales, J. O.; Goldberg, B. B. (Episcopal Hospital, Philadelphia). Semin. Nucl. Med.; 5: No. 4, 339-351(Oct 1975).

Combined ultrasound and nuclear medicine procedures in the evaluation of urinary-tract disease are essentially limited to the kidneys. They are useful in the evaluation of patients with masses, renal failure, unilateral nonfunctioning kidney, trauma, and transplants. In our experience the combined use of these techniques has increased diagnostic accuracy and in many cases has obviated the need for more complex procedures associated with higher radiation doses. This is an especially important factor in children and in adults in the childbearing age group. We have achieved success with these modalities because of the constant communication between the referring physicians and the ultrasound and nuclear medicine divisions. (auth)

3389 APPLICATIONS OF DIAGNOSTIC ULTRASOUND AND RADIONUCLIDES TO CARDIOVASCULAR DIAGNOSIS. I. Acquired Cardiovascular Disease in the Adult. Gottlieb, S.; Sheps, D.; Myerburg, R. J.; Miale, A. Jr. (Univ. of Miami). Semin. Nucl. Med.; 5: No. 4, 353-386(Oct 1975).

Noninvasive methods have become an important part of the diagnostic process for evaluation of cardiovascular anatomy and function in adults and in the young. Because there is a multiplicity of noninvasive methods presently available, in some cases with overlapping capabilities, there has been some confusion as to which constitutes the method of choice in a given clinical circumstance. The reviews that follow outline some of the practical strengths and limitations of two methods (echocardiography and radionuclide cardiography), hopefully thereby providing some rationale for choosing the more appropriate technique in the approach to specific clinical problems. We have found that the information available from radionuclide and from ultrasound studies frequently is complementary and that the most optimal diagnostic results often are obtained when they are combined. Since advances in technique and improvements in instrumentation are occurring continually in both of these areas, we have tried to provide only an overview. Further investigations and clinical experience will help to define the specificity, sensitivity, and capabilities of these methods in terms of present and future applications. (auth)

3390 APPLICATIONS OF DIAGNOSTIC ULTRASOUND AND RADIONUCLIDES TO CARDIOVASCULAR DIAGNOSIS. II. Cardiovascular Disease in the Young. Ferrer, P. L.; Gottlieb, S.; Kallos, N.; Wexler, H.; Miale, A. Jr. (Univ. of Miami). Semin. Nucl. Med.; 5: No. 4, 387-418(Oct 1975).

Echocardiography is an excellent method for detecting structural cardiovascular abnormalities, and it provides important diagnostic information relevant to the care of young patients with a wide variety of cardiac disorders, particularly critically ill newborns with cyanotic congenital heart disease. This information is readily obtainable without moving the infant from the nursery. Later, using radionuclide techniques, left-to-right shunts may be detected and quantitative data obtained relating to the degree of right-to-left shunting; estimation of pulmonary blood flow and scintiphotographic assessment of the patency of surgically created shunts may be made. The noninvasive character of these techniques and their relative freedom of risk make them ideally suited for application to the young. Their present success suggests that their use will become more widespread and that they will contribute significantly to the management of patients in pediatric cardiology. (auth)

3391 NUCLEAR MEDICINE AND ULTRASOUND IN THE EVALUATION OF NEUROLOGIC DISEASES. Whelan, C. A.; Passalaqua, A. M.; Braunstein, P. (New York Univ.). Semin. Nucl. Med.; 5: No. 4, 419-431(Oct 1975).

The role of echoencephalography in neurologic diagnosis depends to some extent upon the availability of computerized transmission tomography. Where CTT is available, its superior ability to objectively evaluate the midline and ventricular size has largely eliminated the use of A-mode echoencephalography. CTT is capable of detecting acute subdural hematomas, and the relative absorption coefficients provide reliable characterization of the nature of a mass lesion. The combination of radionuclide brain scanning and CTT provides complementary information with remarkable sensitivity, to which A-mode echoencephalography

has little to add. When CTT is not available and in situations where the appropriate information can be obtained utilizing ultrasound, A-mode echoencephalography employed by an experienced ultrasonographer may be of clinical value in detecting midline shifts, evaluating hydrocephalus in children, and following patients with CSF shunts. Finally, echoencephalography may provide reassuring information to the clinician dealing with patients with acute head trauma. (auth)

3392 DETECTION OF HEPATITIS A VIRAL ANTIGEN BY RADIOIMMUNOASSAY. Hollinger, F. B.; Bradley, D. W.; Maynard, J. E.; Dreesman, G. R.; Melnick, J. L. (Baylor Coll. Houston, TX). J. Immunol.; 115: No. 5, 1464-1466(Nov 1975).

With coded samples, the effectiveness and specificity of a micro-SPIRA procedure for rapidly and quantitatively detecting type A hepatitis-associated antigen in large numbers of specimens from infected liver, stool, or serum has been demonstrated. Samples which were judged to be negative by IEM were found to contain significant levels of HAV antigen by this immunoradiometric technique. The detection of significant levels of HAV antigen in infected chimpanzees supports epidemiologic evidence of viremia during the acute stage of the disease. The results of this study suggest that the diagnosis of type A hepatitis by a convention serologic procedure may now be at hand. (auth)

3393 EXPERIMENTAL STUDIES ON THE MECHANISM OF OSSIFICATION USING ^{45}Ca. I. Fresh Autograft and Kiel Bone Graft. Fujimoto, A. (Gifu Univ., Japan). Gifu Daigaku Igakubu Kiyo; 22: No. 2, 228-251(Feb 1974). (In Japanese).

In the autologous bone of the same experimental animal, holes of the same size were prepared. Fresh untreated autologous bone, as the control, and Kiel Bone graft were simultaneously transplanted, followed by observation in a chronological sequence using ^{45}Ca as the tracer. The ilium of the dog was studied by macroscopic observation, Softex radiography, and autoradiographic observation. The skull of a rabbit was also studied by these methods, with the addition of histopathological studies. Under macroscopic observation, Softex radiography, and autoradiographic findings at the first and second month, the untreated wound cavity of in the experiment om the dog illium. After 1 month, the wound cavity transplanted with the Kiel Bone graft showed a state of ossification using Softex, while ^{45}Ca uptake was small in amount. In the autograft portion, however, the Softex picture revealed insufficient ossification in the center, with marked ^{45}Ca uptake. It was not until 2 months later that both Softex and autoradiographic pictures indicated a completion of ossification. In the experiment on the rabbit skull, uptake of ^{45}Ca was extremely pronounced in the 1st and 4th week. Based on Softex and histopathological observation, however, ossification was almost completed in the 4th week. (auth)

3394 MEASUREMENT OF RESIDUAL URINE VOLUME USING A RADIOACTIVE TRACER TECHNIQUE. Keller, D. H. (Royal North Shore Hospital, Sydney). Br. J. Urol.; 46: 125(Feb 1974).

A method has now been developed which is not dependent upon patient mobility or collimation. A small quantity of ^{125}I-iodohippurate containing minimal quantities of free ^{125}I is administered intravenously. This agent is cleared by glomerular filtration and tubular secretion during its first passage through the kidneys; the mean renal transit time is 2·9 minutes. The patient is asked to void 2 hours after the injection. The residual volume in the bladder is determined by counting a small aliquot of the urine passed together with a standard of the administered radioactivity, using the principle of dilution. A probe counter can also be used to confirm the results. (auth)

3395 RADIOIMMUNOASSAY FOR SERUM 11-DEOXY-17-KETOSTEROIDS. Sekihara, H.; Ohsawa, N. (Univ. of Tokyo). Steroids; 23: No. 2, 245-258(Feb 1974).

A simplified method for evaluating serum 11-deoxy-17-ketosteroids (11-deoxy-17-KS) equivalent to dehydroepiandrosterone sulfate (DHEAS) has been developed without solvolysis and chromatography. Blood serum or plasma (5 mu l) was added to 1 ml of ethanol, mixed, and centrifuged, and 10 or 20 mu l of the supernatant was evaporated to dryness and incubated with anti-11-deoxy-17-KS antiserum obtained by immunizing a rabbit with DHEA-3,O.CO-BSA which was prepared from DHEA-3,O.COCl and containing DHEAS-7 alpha^{3}H, pepsin-treated human immune serum globulin and bovine serum albumin. Ammonium sulfate was used to separate free from bound DHEAS-7 alpha^{3}H. The accuracy, precision and sensitivity were satisfactory. The blank values could not be differentiated from zero. As the antiserum reacted not only on DHEAS but also on androsterone sulfate and etiocholanolone sulfate, serum 11-deoxy-17KS obtained by the radioimmunoassay expressed nearly the sum of 100 percent of DHEAS, 45 percent of androsterone sulfate and 35 percent of etiocholanolone sulfate in the serum. A good correlation was found between serum 11-deoxy-17-KS and DHEAS obtained by the radioimmunoassay described in a previous paper. The present radioimmunoassay is the simplest method for the evaluation of the concentrations of C_{19} steroids in the serum. (auth)

3396 RADIOISOTOPIC BOLUS TECHNIQUE AS A TEST TO DETECT CIRCULATORY DEFICIT ASSOCIATED WITH CEREBRAL DEATH. Korein, J.; Braunstein, P.; Kricheff, I.; Lieberman, A.; Chase, N. (Univ. of New York, NY). Circulation; 51: No. 5, 924-939(May 1975).

A portable radioisotopic technique was developed to demonstrate cerebral circulatory deficit, as part of a collaborative study to define and diagnose cerebral death simply and rapidly in comatose, apneic patients with electrocerebral silence. The method involves an intravenous injection of 2mCi of $99mTcO_4$ and recording time/activity curves over the cranial cavity and a femoral artery simultaneously, using twin probe radioisotope detector equipment. Eighty comatose, apneic patients had 142 studies in conjunction with clinical electroencephalographic and other laboratory evaluations. The results indicate that the absence of a bolus tracing from the head, as contrasted to the usual bolus seen, is indicative of significant circulatory deficit to the cerebrum. This test may be used as an adjunct in confirming the diagnosis of cerebral death. A normal bolus tracing should be simultaneously observed over a femoral artery and this is used as a control. The method is safe and simple and offers significant information about the irreversibility of cerebral blood flow. Although further studies are indicated, the method appears to be most promising as a fundamental, bedside laboratory test in the diagnosis of cerebral death in conjunction with other clinical and laboratory criteria. (auth)

3397 THALLIUM-201 FOR MYOCARDIAL IMAGING. Relation of Thallium-201 to Regional Myocardial Perfusion. Strauss, H. W.; Harrison, K.; Langan, J. K.; Lebowitz, E.; Pitt, B. (Johns Hopkins Medical Institutions, Baltimore). Circulation; 51: No. 4, 641-645(Apr 1975).

Following intravenous administration, the myocardial concentration of tracer thallium-201, potassium-43, and rubidium-81 were determined in mice; thallium was present in the greatest concentration in the myocardium (2.08 percent compared 1.25 percent for potassium and 1.15 percent for rubidium at 10 minutes). The regional myocardial distribution of thallium-201 was determined in dogs under conditions of normal flow, and total occlusion, and compared with potassium-43 (r equals 0.97). The regional distribution of thallium-201 was compared to microspheres under conditions of partial occlusion and reactive hyperemia (r equals 0.97). Thallium-201 was evaluated in a series of phantom scans, which demonstrated that the low energy x ray of thallium was suitable for imaging. These results suggest that thallium-201 can be used for the evaluation of the distribution of regional myocardial perfusion. (auth)

3398 NONCHROMATOGRAPHIC RADIOIMMUNOASSAY OF PLASMA 11-DEOXYCORTISOL, FOR USE IN THE METYRAPONE TEST, WITH POLYETHYLENE GLYCOL AS THE PRECIPITANT. Lee, L. M. Y.; Schiller, H. S. (Washington School of Medicine, Seattle). Clin. Chem.; 21: No. 6, 719-724(May 1975).

We have developed a simple, reliable radioimmunoassay for plasma 11-deoxycortisol. The method does not require chromatography but instead makes use of a simple extraction procedure which, in combination with the antibody characteristics, is highly specific for the metyrapone test. Polyethylene glycol was used to separate free and antibody-bound steroid. The smallest amount measurable is 15 pg (2.0 mu g/liter of plasma). The method is shown to be precise and accurate. Intra-assay precision of the method for two plasma pools was 26.7 +- 2.5 mu g/liter (CV equals 9.4 percent) and 61.2 +- 3.7 mu g/liter (CV equals 6.0 percent). The respective inter-assay precision was 27.0 +- 1.7 mu g/liter (CV equals 6.3 percent) and 59.9 +- 2.3 mu g/liter (CV equals 3.8 percent). The validity of the assay was further verified by evaluating the plasma 11-deoxycortisol response to metyrapone administration. The relative simplicity of the method and the commercial availability of all reagents, including antisera, makes this radioimmunoassay procedure practical for use in clinical laboratories. (auth)

3399 RADIOIMMUNOASSAY OF PLASMA TESTOSTERONE, WITH USE OF POLYETHYLENE GLYCOL TO SEPARATE ANTIBODY-BOUND AND FREE HORMONE. Anderson, P. H.; Fukushima, K.; Schiller, H. S. (Washington School of Medicine, Seattle). Clin. Chem.; 21: No. 6, 708-714(May 1975).

We have developed a reliable radioimmunoassay for testosterone in plasma, polyethylene glycol ("Carbowax 6000") being used to separate antibody-bound and free hormone. Testosterone is separated from interfering steroids, notably dihydrotestosterone, by liquid-liquid partition chromatography on infusorial earth (Celite).

The assay is sensitive (9 pg for standards), precise, and accurate. The lowest measurable concentration of testosterone is 350 ng/liter for plasma from men and 70 ng/liter for plasma from women. Intra- and inter-assay coefficients of variation were 6.9 percent and 9.7 percent, respectively, for plasma from men, and 9.6 percent and 11.8 percent, respectively, for plasma from women. Our method for separating antibody-bound and free hormone is practical and convenient and may be generally applicable to all radioimmunoassays of steroid hormones in plasma. (auth)

3400 IMPROVED RADIOIMMUNOASSAY OF PLASMA CORTISOL. Donohue, J.; Sgoutas, D. (Emory Univ., Atlanta). Clin. Chem.; 21: No. 6, 770-773(May 1975).

We report a simplified radioimmunoassay procedure for determination of plasma cortisol. The method offers the advantage that tracer, antibody, and assay buffer are added in a single step with the use of semi-automated equipment. Thus, critical pipetting procedures are minimized, and assay time is reduced to 4 h. No prior extraction or chromatographic purification of cortisol is required. The procedure is simple, reliable, and accurate. For either between-assay or within-assay determinations, the coefficients of variation are about 6 percent. Our results compare well with those obtained from a procedure that included extraction and chromatographic purification of cortisol in several plasma samples. Conditions for optimizing the assay are also discussed. (auth)

3401 COMPARISON OF RADIOIMMUNOASSAY WITH THIN-LAYER CHROMATOGRAPHIC AND GAS–LIQUID CHROMATOGRAPHIC METHODS OF BARBITURATE DETECTION IN HUMAN URINE. Roerig, D. L.; Lewand, D. L.; Mueller, M. A.; Wang, R. I. H. (Veterans Administration Center, Milwaukee). Clin. Chem.; 21: No. 6, 672-675(May 1975).

A radioimmunoassay (I) for barbiturates was compared with thin-layer chromatographic (II) and gas–liquid chromatographic (III) methods for barbiturate detection in human urine. Timed urine samples were obtained from volunteers who had ingested 100 mg of a barbiturate. I detected barbiturate in all urines tested up to 76 h after the dose, and III in all up to 52 h and in 90 percent up to 76 h. II detected barbiturates in 90 percent of all urine samples for only 30 h, after which its reliability declined. Glutethimide interfered with radioimmunoassay of barbiturate, producing false positives. I is sensitive, reliable, and fast, and lends itself to screening large numbers of urine samples for barbiturates. For routine urine surveillance, however, we found I to be less useful than II, which is still the method of choice. I has, however, proved to be an excellent method for confirming results of II. (auth)

MATERIALS

3402 (ORNL-TM--960) FUELS AND MATERIALS DEVELOPMENT PROGRAM QUARTERLY PROGRESS REPORT FOR PERIOD ENDING SEPTEMBER 30, 1964. Patriarca, P. (comp.). (Oak Ridge National Lab., Tenn. (USA)). Nov 1964. Contract W-7405-eng-26. 62p. Dep. NTIS $5.50.

The following are reported: fuel element development (deposition of UO_2 and W–Re, fabrication of Al-base fuel plates, H_2 sorption by Al, UC fabrication with fugitive sintering aids); nondestructive test development (electromagnetic, ultrasonic, penetrating-radiation); solid reaction studies (diffusion of ^{95}Nb into Ta monocrystals); and Zr metallurgy (Ti–Zr alloys, hydride precipitation in stressed Zircaloy-2, optical properties of Zr, preparation of monocrystals of Zr, zone refining of Zr, refractive indices of anodized oxide films stripped from Zr). (6 tables, 10 fig) (DLC)

3403 (ORNL-TM-1000) FUELS AND MATERIALS DEVELOPMENT PROGRAM QUARTERLY PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1964. Patriarca, P. (comp.). (Oak Ridge National Lab., Tenn. (USA)). Feb 1965. Contract W-7405-eng-26. 90p. Dep. NTIS $6.00.

Reported are: fuel element development (CVD deposition of UO_2, W–Re, and doped W; fabrication of UC with fugitive sintering aids; fabrication of W–1 percent YAl_2 or $CeAl_2$); mechanical properties (ductility of irradiated Type 304 stainless steel, Cu, Fe, and Ni; tensile properties of irradiated Types 304, 302, and 316 stainless steel); nondestructive test development (electromagnetic, ultrasonic, penetrating-radiation); solid reaction studies (diffusion of ^{95}Nb and ^{182}Ta in Nb); and Zr metallurgy (anisotropy in Zircaloy 2, monocrystal preparation, zone refining, recrystallization structures). (DLC)

3404 (ORNL-TM-5029) FUELS AND MATERIALS DEVELOPMENT PROGRAM QUARTERLY PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1975. Patriarca, P. (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 40p. AT.

Advanced Absorber Materials: Thermal expansion of Eu_2O_3 was measured to 1500°C. Density variations in sintered Eu_2O_3 pellets were determined. Fabrication methods and thermal conductivity of Eu_2O_3–metal (W, Re) cermets were evaluated. Postirradiation examinations of europia pellets and pins are reported. Mechanical and Metallurgical Behavior of Weldments for LMFBR: 1200°F creep-rupture properties of Type 308 CRE stainless steel (ss) shielded metal-arc welds and elastic constant variations in Type 304–308 ss weldments are reported. Findings of the Task Force on Alternate Structural Materials for LMFBRs are summarized. Post-test examination of the Sodium Component Test Installation-Intermediate Heat Exchanger included the valves. (DLC)

3405 MAGNETISM AND MAGNETIC MATERIALS, 1974. Twentieth Annual Conference Held at San Francisco, California, December 3–6, 1974. Graham, C. D. Jr.; Lander, G. H.; Rhyne, J. J. (eds.). AIP Conference Proceedings, Number 24. New York; American Institute of Physics (1975). 812p. (CONF-741202-).

A total of 382 papers and abstracts are presented. Topics covered include: valence effects, rare earth compounds, chalcogenides, magnetite, amorphous and disordered systems, spin waves, magneto-optics, exchange hyperfine fields, band structure, crystal fields, singlet ground states, phase transitions, critical phenomena, theory, actinides, surfaces and small particles, metals and alloys, microwave devices, resonance and relaxation, recording and storage, bubble devices, magneto-elastic and anisotropy effects, rare earth permanent magnets, and soft and hard magnetic materials. Separate abstracts were prepared for 81 of the papers for NSA and 22 of the papers for ERA. (DLC)

For abstracts of individual papers see: 2589, 3440–3459, 3562–3620, and 3639.

Ceramics and Cermets

Refer also to abstracts 2688, 3469, 3476, 3478, 3482, 3499, 3512, 3518, 3552, 3553, 3638, 4078, 4654, and 4659.

3406 (AERE-R–8091) INFLUENCE OF IMPURITIES ON THE HOT-HARDNESS OF URANIUM MONONITRIDE. Pape, R. P.; Waite, M. P. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Aug 1975. 24p. Dep. NTIS. (US Sales Only) $4.50. UK pounds 1.00.

Vickers Pyramid Hardness numbers of uranium mononitride specimens doped with various impurities were measured between 20 and 1400°C in vacuo. It was shown that for both pure and impure UN, there is a fundamental change in deformation mechanism at about 650°C. Above this temperature, the hardness of pure UN falls smoothly with rising temperature up to at least 1400°C; however, the hardness of impure UN changes with temperature in a way which indicates that there is a phenomenon which inhibits thermally activated softening at about 900–1200°C. The presence of inert second phases has little effect on the hardness, but supersaturation with dissolved impurity has a pronounced effect, probably due to inhibition of the change to the higher-temperature deformation mechanism. (auth)

3407 (HEDL-TME-75-91) REACTION OF SiO_2 AND Al_2O_3 WITH $(U,Pu)O_2$. Gibby, R. L.; Clark, W. I. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Jun 1975. Contract AT(45-1)-2170. 19p. AT.

High temperature reactions of Al_2O_3 and SiO_2 with PuO_2 and UO_2–25 wt percent PuO_2 were investigated under conditions of temperature and oxygen activity similar to what could be encountered in a typical oxide fuel pellet sintering process. Several reaction products were identified and characterized by x-ray diffraction and electron microprobe analyses. The results were used to help identify and characterize local impurity concentrations which have been observed on sintered FTR-type fuel pellets. (auth)

3408 (INIS-mf-1703, pp 78–89) RADIATION HARDENING OF THE Zr + 1% Nb ALLOY IN THE TEMPERATURE RANGE FROM 285 TO 350°C. Belokopytov, V. S.; Losev, N. P.; Mel'der, R. R.; Samsonov, B. V.; Fin'ko, A. G.; Tsykanov, V. A. 1974. (In Russian)

From jubilee conference dedicated to the twentieth anniversary of nuclear power engineering; Obninsk, USSR (25 Jun 1974).

In nuclear power plant operating experience and prospects of nuclear power engineering. Vol. 2. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow).

Studies are presented on strengthening of the alloy zirconium + 1% niobium during its irradiation. The dose-temperature region of the strengthening was investigated. It is shown that in the temperature interval from 185 to 350°C and an irradiation dose up to 10^{19} neutrons per cm^2 ($E > 0.85$ Mev), strengthening takes place, which is greater, the lower is the sample temperature. (tr-SJR)

3409 (INIS-mf-1703, pp 139–153) STUDIES DURING THE DEVELOPMENT OF CORROSION STABLE ZIRCONIUM ALLOYS FOR USES IN SUPERHEATED STEAM. Zaimovskii, A. S.; Nikulina, A. V.; Udalova, I. V. 1974. (In Russian)

From jubilee conference dedicated to the twentieth anniversary of nuclear power engineering; Obninsk, USSR (25 Jun 1974).

In nuclear power plant operating experience and prospects of nuclear power engineering. Vol. 2. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow).

Results of experimental studies are presented on the effects of alloying elements (iron, chromium, and copper) on the corrosion resistance of zirconium alloys in superheated steam at temperatures of 350 to 500°C. A look is taken at binary, ternary, and quaternary systems. An analysis is made of the effect of temperature and duration of testing in superheated steam on the diffusion of oxygen in the zirconium alloys. Kinetic curves are presented for the corrosion process in alloys TsXX-1, TsSM-1, and Valloy at temperatures up to 500°C. Results are presented of the embrittlement of zirconium alloys depending on the corrosion process as a function of the state of the coolant, flow rate and oxygen content in the coolant. (tr-SJR)

3410 (LA-6083-T) OXYGEN POTENTIAL OF URANIUM–PLUTONIUM OXIDE AS DETERMINED BY CONTROLLED-ATMOSPHERE THERMOGRAVIMETRY. Swanson, G. C. (Los Alamos Scientific Lab., N. Mex. (USA)). Oct 1975. Contract W-7405-ENG-36. 130p. Dep. NTIS $5.45.

Thesis.

The oxygen-to-metal atom ratio, or O/M, of solid solution uranium-plutonium oxide reactor fuel is a measure of the concentration of crystal defects in the oxide which affect many fuel properties, particularly, fuel oxygen potential. Fabrication of a high-temperature oxygen electrode, employing an electro-active tip of oxygen-deficient solid-state electrolyte, intended to confirm gaseous oxygen potentials is described. Uranium oxide and plutonium oxide O/M reference materials were prepared by in situ oxidation of high purity metals in the thermobalance. A solid solution uranium-plutonium oxide O/M reference material was prepared by alloying the uranium and plutonium metals in a yttrium oxide crucible at 1200°C and oxidizing with moist He at

250°C. The individual and solid solution oxides were isothermally equilibrated with controlled oxygen potentials between 800 and 1300°C and the equilibrated O/M ratios calculated with corrections for impurities and buoyancy effects. Use of a reference oxygen potential of -100 kcal/mol to produce an O/M of 2.000 is confirmed by these results. However, because of the lengthy equilibration times required for all oxides, use of the O/M reference materials rather than a reference oxygen potential is recommended for O/M analysis methods calibrations. (auth)

3411 PHYSICAL CHEMICAL PROPERTIES OF TEMPERATURE-STABLE FERRITES CONTAINING ADDITIONS OF TRANSITION METAL OXIDES. Glotov, V. G.; Zinov'eva, I. G.; Pronin, L. A. (Scientific-Research Center for Electronic Higher Technology, Moscow). pp 119-124 of Elektronnoe Stroenie i Fizicheskie Svoistva Tverdogo Tela. Chast I. Samsonov, G. V. (ed.). Kiev; Izdatel'stvo Naukova Dumka (1972). (In Russian)

From 7th all-union conference on the physical properties and electron structure of transition metals, their alloys, and compounds; Kiev, USSR (1969).

In order to increase the operating speeds of electronic computers it is necessary to increase the rate of magnetization of ferrites used in memory systems. It was found that the addition of 2, 5, 7 and 10 wt% ZrO_2 or HfO_2 to lithium–manganese ferrites leads to a change in coercive force of the material and to an improvement in the pulse parameters which is important in the use of ferrites in fast memories. (SJR)

3412 INTERACTION OF RARE EARTH OXIDES WITH CALCIUM, STRONTIUM, AND EUROPIUM OXIDES. Lugin, L. I.; Kushchevskii, A. E.; Gerasimyuk, G. I.; Shevchenko, A. V.; Lopato, L. M. (Inst. of Problems in Materials Science, Kiev). pp 166-172 of Elektronnoe Stroenie i Fizicheskie Svoistva Tverdogo Tela. Chast I. Samsonov, G. V. (ed.). Kiev; Izdatel'stvo Naukova Dumka (1972). (In Russian)

From 7th All-Union conference on the physical properties and electron structure of transition metals, their alloys, and compounds; Kiev, USSR (1969).

X-ray studies of samples in the system La_2O_3–CaO and Pr_2O_3–CaO rich in rare earth oxides showed the formation of solid solution with La_2O_3 and Pr_2O_3 as a base having a structure of an A-type rare earth oxide. The limiting solubility of CaO in La_2O_3 attains 20 mol % at 1885°C and falls with decreasing temperature to 15 mol % at 1700°C. The solubility of CaO in Pr_2O_3 at 1960°C is 22 mol % which decreases to 16 mol % CaO at 1700°C. The solubilities of La_2O_3 and Pr_2O_3 in calcium oxide are ~1 mol %. In the presence of CaO, a decrease was noted in the temperatures of the polymorphic transformations A → H and H → X. The solubility of SrO in rare earth oxides varies from 21 to 25 mol % in the series from Nd to La. The limiting solubility of rare earth oxide in SrO is ~6 mol %. A beta phase forms at higher temperatures of 1800 to 2000°C with Sm_2O_3 and Dy_2O_3. A phase diagram of the La_2O_3–CaO system is presented. (SJR)

3413 FUEL ELEMENT FABRICATION PLANT FOR SUPER PHENIX. Vialard, J. L.; Heyraud, J.; Pajot, J. (CEA Centre d'Etudes Nucleaires de Chadarache, 13 - Saint-Paul-les-Durance (France). Dept. de Developpement des Elements Combustibles). pp 221-225 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French)

From 1st European nuclear conference; Paris, France (21 Apr 1975).

The fabrication process of pellets, pins, and assemblies is described together with the equipment used. The implantation and surface of the fabrication unit are given. The unit is designed to supply 18 tons of Super Phenix fuel per year. (FR)

3414 PLUTONIUM FUEL DEVELOPMENT AND PRODUCTION. Flipot, A. J. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)); Leblanc, J. M.; Lafontaine, I. (Societe Belge pour l'Industrie Nucleaire, Brussels). pp 219-220 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French)

From 1st European nuclear conference; Paris, France (21 Apr 1975).

An improved method for fast reactor pellet preparation was developed and tested. It reduces the number of manufacturing steps to three: mixing, pelletizing, and sintering. The advanced technology allows obtaining sintered pellets with the limits of diametral margins, avoiding mechanical grinding. A pilot plant and a production plant were put into operation in 1968 and in 1973, respectively. The Dessel Pu plant was designed to allow the fabrication of any UO_2–PuO_2 fuel rod types and to reach, during a first step, a production capacity of 30 tons per year of a reference BWR fuel. (FR)

3415 MAGNETIC STRUCTURES OF U_2N_2M-TYPE COMPOUNDS. Leciejewicz, J.; Zolnierek, Z.; Ligenza, S.; Ptasiewicz, H.; Troc, R. (Inst. of Nuclear Research, Warsaw). J. Phys., C (London); 8: No. 11, 1697-1704(7 Jun 1975).

The magnetic structures and the magnitudes of the ordered magnetic moments for the hexagonal ternary U_2N_2M-type compounds (where M is P, As, S, Se) were determined by neutron diffraction. In U_2N_2S and U_2N_2Se, the observed magnetic unit cells have the same size as the chemical ones while in U_2N_2P and U_2N_2As the magnetic unit cell is doubled along the c-axis. At 4°K the magnetic moments on the uranium ion amount to 1.4, 1.7, 1.6, and 2.3 μ_B for U_2N_2S, U_2N_2P, U_2N_2As, and U_2N_2Se, respectively. In all of them the direction of the magnetic moment is along the c-axis. (auth)

3416 CHOICE OF "MUFFIN-TIN" SPHERE RADII IN APW BAND-STRUCTURE CALCULATIONS OF VC. Schwarz, K.; Pechter, K.; Neckel, A. (Technische Hochschule, Vienna). J. Phys., C (London); 8: No. 11, 1663-1670(7 Jun 1975).

A new self-consistent band-structure calculation for stoichiometric vanadium carbide is performed by means of the augmented plane wave method using a ratio of atomic sphere radii R_C/R_V = 0.645. Results are compared with a similar calculation based on the ratio 0.899. It is demonstrated how the choice of sphere radii affects the potentials, the band structure, and the charge distribution. A recommendation for determining the atomic sphere radii is given. (auth)

3417 STUDIES OF NEUTRON IRRADIATION DAMAGE IN CaO:I. Hall, T. P. P. (Univ. of the Witwatersrand, Johannesburg). J. Phys., C (London); 8: No. 12, 1921-1927(21 Jun 1975).

Neutron-irradiated CaO has an EPR spectrum at 77°K with g-values $g_{\parallel}$ (100) = 2.0694, $g_{\perp}$ = 2.0021, due to a V^- center which differentiates it from previously reported values, suggesting a distinction between the V^- centers produced in this way from those produced thermally. The temperature dependence of this spectrum shows features of motional averaging. At 195°K, a broad isotropic line g(iso) = 2.0475 (approximately $\frac{1}{3}(g_{\parallel} + 2g_{\perp})$) is observed, confirming that this is indeed an intrinsic V^- center. Further centers were discovered which are tentatively identified as interstitial O_2^- along ⟨110⟩ axes and a weaker spectrum of similar centers with the axes tilted by about 14.5° from ⟨110⟩ lying in the corresponding (001) plane. Interpretation of these results is discussed. (auth)

3418 MAGNETIC SUSCEPTIBILITY OF $^{243}AmO_2$. Karraker, D.G. (Savannah River Laboratory, E. I. du Pont de Nemours and Company, Aiken, South Carolina 29801). J. Chem. Phys. 63: No. 7, 3174-3175 (1 Oct 1975).

The magnetic susceptibility of $^{243}AmO_2$ from 2.2 to 97°K. The sample showed an antiferromagnetic transition at 8.5±0.5 °K and to regions of temperature-dependent paramagnetism above 15 °K. (AIP)

3419 PRESSURE DEPENDENCE OF THE ABSORPTION EDGE OF SOME DIVALENT RARE-EARTH MONOCHALCOGENIDES. Johansson, B. (FOA He 2, Stockholm 80, Sweden). Phys. Rev. B 12: No. 8, 3253-3257 (15 Oct 1975).

By means of thermodynamic principles, the pressure dependence of the $4f \rightarrow 5d$ excitation energy is calculated for some divalent rare-earth chalcogenides. The agreement with experiment is rather satisfactory. Implications on the pure metals europium, ytterbium, and cerium are discussed. For the two former elements a valence transition is estimated to take place at a pressure of about 175 and 140 kbar, respectively. Also, ytterbium monoxide is briefly commented on. (auth)

3420 LATTICE DISTORTION AND NUCLEAR MAGNETIC RESONANCE IN THE DIAMOND-LIKE MODIFICATIONS OF BORON NITRIDE. Kurdyumov, A. V.; Pilyankevich, A. N.; Tikhonenko, K. A.; Shul'man, L. A. (Inst. of Problems in Materials Science, Kiev). Sov. Phys.-Solid State; 16: No. 6, 1170-1171(Dec 1974).

Translated from Fiz. Tverd. Tela; 16: No. 6, 1798-1800(Jun 1974).

Nuclear magnetic resonance and x-ray methods were used in the study. It was found that the observed differences in the spectra of the diamond-like modifications of BN are due basically to the presence of oriented distortion of the coordination tetrahedra in the wurtzite type (BN_w) structure, which vary the distribution of the bonds and as a consequence their energy characteristics. However, the constants of the quadrupole interaction for Bn_w and sphalerite type (BN_{sph}), although they are different, are two orders of magnitude smaller than for graphite-like boron nitride (BN_{gr}). This result is in agreement with the conclusion that BN_w obtained under shock compression conditions occupies an intermediate

position between BN_{gr} and BN_{sph} in anisotropy of the chemical bonds (substantially closer to BN_{sph}). (JRD)

3421 ELECTRONIC CONDUCTION IN OXIDES AT ELEVATED TEMPERATURES. Blumenthal, R. N. (Marquette Univ., Milwaukee). J. Solid State Chem.; 12: 307-318(1975).

A brief discussion of the defect models and experimental techniques used to characterize the electrical conductivity of insulating and semiconducting oxides are presented. Emphasis is on the electronic conduction at elevated temperatures, where the oxide may be equilibrated with the ambient atmosphere. Where appropriate, typical examples of oxides are selected to emphasize (1) how information about defect structures and transport properties of the defects in oxides may be obtained from a combined analysis of different types of experimental data, and (2) some of the experimental and theoretical problems which are limiting the understanding of the electronic conductivity of insulating and semiconducting oxides and their application to technology. (39 references) (auth)

3422 HIGH TEMPERATURE DEFORMATION BEHAVIOR OF CEMENTED CARBIDE CUTTING TOOLS. Baldoni, J. G. II. Urbana, IL; Univ. of Illinois (1975). 181p. University Microfilms Order No. 75-14,078.

Thesis (Ph. D.).

Sections of commercial cemented carbide metal cutting tools, both straight WC–Co and multi-carbide-Co, were tested at high temperature, in vacuo, in uniaxial compression. For stresses up to 50 kg/mm^2 and temperatures below approximately 1050^{0}C the materials were found to show elastic response. In the temperature range of 1050 to 1200^{0}C, irreversible deformation was observed at stress levels below 50 kg/mm^2. The temperature for the onset of this deformation was found to depend upon composition, increasing with increasing amounts of cubic carbide and decreasing cobalt content. After a certain amount of irreversible deformation, the amount being dependent on composition and temperature, the materials again showed a linear relationship between stress and strain. The amount of irreversible deformation was found to decrease with increasing cubic carbide additions, decreasing cobalt content, and decreasing temperature. The return of the samples to a linear stress-strain relationship is interpreted as the cessation of "plastic" deformation and the reappearance of elastic response. A model based on densification by grain boundary sliding with accompanying plastic deformation in the binder phase and some deformation of carbide grains at points of contact is presented to explain the observations. Scanning electron microscopic studies of carbide grain shapes indicate that gross plastic deformation of the individual grains did not occur at the stress levels and temperatures studied (up to 1200^{0}C) despite the macroscopic changes in shape and dimensions of the samples. (Diss. Abstr. Int., B)

3423 NEW ORDERED STRUCTURE IN THE NIOBIUM–NITROGEN SYSTEM. Jung, P.; Schober, T. (Kernforschungsanlage, Juelich, Ger.). Scr. Metall.; 9: No. 9, 949-953(Sep 1975).

Nb foils were doped with N to levels of 1.4 and 2.9 at. percent N by resistance heating at 1800^{0}C in N_2 and then quenched by switching off the heating current. Transmission electron microscopy and resistivity measurements were performed. The specimens were also annealed at 330^{0}C. After quenching, neither ordering nor precipitates were observed in the 1.4 at. percent N samples, while in the 2.9 at. percent sample the dislocations were decorated with Nb_2N precipitates. Annealing at 330^{0}C was found to form superlattices, as evidenced by the decreased resistivity. Nb_2N precipitation could be accelerated by raising the temperature to 450^{0}C. Samples with N contents of 20 at. percent were also produced with strong superlattice reflections. (DLC)

3424 CHEMICAL HYSTERESIS IN PHASE TRANSITIONS IN THE TbO–O SYSTEM. Lowe, A. T.; Eyring, L. (Arizona State Univ., Tempe). J. Solid State Chem.; 14: No. 4, 383-394(Aug 1975).

A thermogravimetric study of hysteresis in the TbO/sub x/–O_2 system has provided insight into phase transitions occurring among the fluorite-related rare earth oxides. A series of isobaric scanning loops at 380 torr have been made. The scans were between $TbO_{1.5}$(phi) and $TbO_{1.714}$(l) at higher temperatures and between $TbO_{1.714}$(l) and $TbO_{1.818}$(delta) at lower temperatures. Corresponding isobaric studies were made utilizing high temperature x-ray powder diffraction to augment the TGA experiments. It was confirmed that sections of the lower temperature loop were dependent on the rate of temperature change while the higher temperature loop was entirely reproducible. Interior scanning loops made within the lower hysteresis loop showed univariant behavior typical of a single phase when reversed in the delta'delta pseudophase region, otherwise it exhibited bivariant behavior. The upper hysteresis loop showed bivariant behavior throughout the interior of the loop. Some thermodynamic aspects and the microdomain concept as applied to hysteresis are also considered. (auth)

3425 SOME PROPERTIES OF InN FILMS PREPARED BY REACTIVE EVAPORATION. Trainor, J. W.; Rose, K. J. Electron. Mater.; 3: No. 4, 831-828(Nov 1974).

Some optical and electrical properties of degenerate InN films prepared by a reactive evaporation technique are presented. Thermal stability of these easily dissociated samples is discussed and evidence is presented indicating that the partial pressure of atomic N rather than diatomic N is a more fundamental parameter for describing thermal equilibrium. This has important implications for the growth of all Group III nitrides. (Metals Abstr.)

3426 ON THE COMPOUNDS IN Li_2O-B_2O_3-H_2O SYSTEM. Nakamura, S.; Hayashi, H. (Government Industrial Research Inst., Nagoya (Japan)). Yogyo Kyokai Shi; 83: No. 953, 38-45 (Jan 1975). (In Japanese).

Some compounds in the ternary system Li_2O-B_2O_3-H_2O were synthesized, e.g., LBH_{16} (L: Li_2O, B: B_2O_3, H: H_2O), LBH_4, LB_2H_3, LB_5H_{10} etc. Each compound was confirmed to be single phase by means of chemical analysis, DTA, TGA and X-ray diffraction. The compound LBH_{16} is hexagonal with the lattice parameter $a_0 = 5.70$ and $c_0 = 6.20$ Å. The diffraction data of "LBH_{16}" did not coincide with those of the synthesized LBH_{16}, and should be attributed to LBH_4 contaminated with small amounts of LB_2H_3. The diffraction data of synthesized LBH_4 were not consistent with those of "LBH_4", and practically agreed with those of LBH_4 reported by Sastry and Hummel [J. Am. Ceram. Soc. 41: 7 (1958)]. Instead of "LBH", LBH_x with variable x smaller than 1 was obtained through dehydration of LBH_4. The diffraction data of the synthesized LB_2H_3 agreed approximately with those of "LB_2H_4" and "LB_2H_5", and those of LB_2H_3 reported Bouaziz [Bull. Soc. Chem. (France) 2: 1451 (1962)] were in rough agreement with the data of LB_2H_x which was obtained in the course of dehydration process of the synthesized LB_2H_3. (auth)

3427 MEASUREMENT OF THERMAL PROPERTIES OF NUCLEAR MATERIALS BY LASER FLASH METHOD. Takahashi, Y.; Murabayashi, M. (Tokyo Univ. (Japan). Faculty of Engineering). J. Nucl. Sci. Technol. (Tokyo); 12: No. 3, 133-144 (Mar 1975).

71 refs.

The present status and prospects of the laser flash method for the measurement of thermal properties of nuclear materials are reviewed. Special emphasis is placed on the progress seen in experimental techniques for obtaining precise data on heat capacity and thermal diffusivity from 80 to 1,000 K. In this temperature range, the heat capacity and the thermal diffusivity of ceramic nuclear materials can be determined within a precision of ±2%. The data on heat capacity and thermal conductivity determined by the laser flash method are presented and discussed in respect of such nuclear materials as UO_2, U_4O_9, ThO_2, BeO, ThO_2-UO_2, ThO_2-CeO_2, UO_2-ZrO_2, ThO_2-BeO, UC, UN, US, UP, $UC_{1-x}N_x$ and $UP_{1-x}S_x$ (auth)

3428 MICROSTRUCTURE AND PROPERTIES OF FUSED-CAST $NaNbO_3$–$BaTiO_3$ CERAMICS. Ito, Setsuro; Kokubo, T.; Tashiro, M. (Kyoto Univ., Uji (Japan). Inst. for Chemical Research). Bull. Inst. Chem. Res., Kyoto Univ.; 52: No. 5-6, 641-651(Nov 1974).

A fusion cast method was applied to fabricating dense polycrystalline ferroelectric $NaNbO_3$-$BaTiO_3$ ceramics, which are difficult to densify by the conventional sintering method. By casting the melt of the composition $0.7NaNbO_3 \cdot 0.3BaTiO_3$ previously heated at 1500°C into a cylindrical graphite mold held at 500°C and subsequently cooling it in a laboratory atmosphere, a dense ceramic composed mainly of columnar crystals except for near the center of the mold was obtained. The crystals precipitated were the perovskite-type $NaNbO_3$-$BaTiO_3$ solid solution and their (111) or (211) planes were orientated parallel to the inner surface of the mold. Porosity and dielectric constant of the fused-cast ceramic were 3.6% and 2900, whereas those of the sintered ceramic of the same composition were 24.7% and 2200, respectively. Addition of the SiO_2 in amount of 0.03 and ratio to the base composition of the fused-cast ceramic was found to be strongly effective in decreasing its porosity to 1.0%, without producing the appreciable detrimental effect on its dielectric constant. (auth)

3429 PHASE EQUILIBRIUM OF Y_2O_3-TiO_2. Mizutani, N.; Kitazawa, A.; Kato, M. (Tokyo Inst. of Tech. (Japan). Faculty of Engineering). Nippon Kagaku Kaishi; 1974: No. 9, 1623-1628 (Sep 1974). (In Japanese).

The phase equilibrium relationship of Y_2O_3-TiO_2 system in air was determined in the temperature range between 800°C and 1600°C. Coprecipitants of Y(III) and Ti(IV) hydroxides were used as the samples for temperature range below 1200°C, while mixtures of Y_2O_3 and TiO_2 powders were used for the higher

temperature range. The samples were heated for 2 to 30 days, quenched in liquid nitrogen and analysed by x-ray diffraction. Four compounds, α-Y_2TiO_5, β-Y_2TiO_5, $Y_2Ti_2O_7$ and fluorite type compound ($Y_xTi_{1-x}O_{2-x}/2\square x/2$) were identified in this system. The α-Y_2TiO_5 with orthorhombic lattice is stable below 1330°C. The β-Y_2TiO_5 with hexagonal lattice, $a_0 = 3.615$ Å, $c_0 = 11.838$ Å is stable between 1330°C and 1520°C, and at higher temperature it changes into fluorite type cubic solid solution. The solubilization of TiO_2 or Y_2O_3 was observed neither α- nor β-Y_2TiO_5. Only a small amount of TiO_2 and Y_2O_3 are soluble in cubic pyrochlore type ($Y_2Ti_2O_7$) below 1400°C, while above 1450°C, Y_2O_3 is markedly soluble in it and the produced solid solution gradually changes its structure from pyrochlore to fluorite type. The lowest temperature at which the fluorite phase is stable is 1390°C, when the solution contains 43.7 mol% TiO_2 and its region becomes wide with increase of temperature. (auth)

3430 HIGH TEMPERATURE PHASE IN THE ZrO_2-Sc_2O_3 SYSTEM. Sekiya, T.; Yamada, T.; Hayashi, H.; Noguchi, T. (Government Industrial Research Inst., Nagoya (Japan)). Nippon Kagaku Kaishi; 1974: No. 9, 1629-1636(Sep 1974). (In Japanese).

The liquidus curve of the ZrO_2-Sc_2O_3 system was measured from the cooling curve of a specimen by the specular reflection method with a heliostat type solar furnace. Quenched specimens from the melt were investigated by x-ray diffraction techniques and a petrographic microscope. The single phase of ZrO_2 solid solution having the structures of tetragonal form, rhombohedral form I and rhombohedral form II were obtained by quenching the melt containing 6 to 8 mol % Sc_2O_3, 12 to 14 mol % Sc_2O_3 and 16 to 22 mol % Sc_2O_3, respectively, and also the rhombohedral form II was obtained by firing the specimen containing 18 to 20 mol % Sc_2O_3 at 1700°C for 5 hours. The solubility limit of Sc_2O_3 in the cubic ZrO_2 solid solution was located at 45 mol % Sc_2O_3 and that of ZrO_2 in the Sc_2O_3 solid solution was located at 26 mol % ZrO_2. It was found that two rhombohedral phases in the quenched specimens from the melt were consisted of twinning crystals of various types under the microscopic observation. (auth)

3431 CHANGES OF THE LATTICE PARAMETER AND DENSITY OF $TiO_{1\pm x}$ BY NEUTRON IRRADIATION. Honma, T.; Matsumoto, M.; Shugo, Y. (Tohoku Univ., Sendai (Japan). Research Inst. of Mineral Dressing and Metallurgy). Tohoku Daigaku Senko Seiren Kenkyusho Iho; 30: No. 1, 29-36(Sep 1974). (In Japanese).

In the composition at the vicinity of $TiO_{1.00}$ of the NaCl-type crystal structure, the vacancies are distributed randomly on the cells of the titanium sublattice and oxygen sublattice. In order to study the effect of the neutron irradiation for the NaCl-type titanium monoxides, the lattice parameter and density were measured, and the differential thermal analysis was performed on the samples which have been neutron irradiated and unirradiated ($TiO_{0.942}$, $TiO_{0.999}$ and $TiO_{1.175}$). The lattice parameter contracted by 0.9% for $TiO_{0.942}$ and 0.2% for $TiO_{0.999}$, but it expanded by 0.4% for $TiO_{1.175}$ by the neutron irradiation. The rate of change of the lattice parameter, $(\alpha-\alpha_0)/\alpha_0$, changes along with a linear relation from "minus" to "plus" with the increase of O/Ti. The density decreases by the neutron irradiation for $TiO_{0.942}$, $TiO_{0.999}$ and $TiO_{1.175}$. The rate of change of density increases with the increase of O/Ti. The concentration of the vacant lattice sites in the titanium and oxygen sublattices and the concentration of the total vacant lattice sites in the total lattice increase by the neutron irradiation. In the measurement of the differential thermal analysis conducted for the neutron irradiated $TiO_{0.999}$, the two broad peaks were observed in a temperature range from 250 to 800°C. These peaks may indicate that the neutron irradiation damage recovers by a two-step mechanism. (auth)

3432 INVESTIGATION OF THE COMPTON PROFILE OF BN, BeO, AND AlN ALLOWING FOR THE STATE OF VALENCE ELECTRONS IN CRYSTALS. Kuplyauskis, Z. I.; Yakimavichyus, I. A. (Vilnyus State Univ., USSR). Sov. Phys. - Solid State (Engl. Tranl.); 16: No. 9, 1832-1833(Mar 1975).

Translated from Fiz. Tverd. Tela; 16: No. 9, 2815-2817(Sep 1974).

Compton profiles were calculated for BN, BeO, and AlN with the valence electron configurations corresponding to free atoms, ions, and valence states in crystals. (DLC)

3433 FIELD EFFECTS IN VO_2 FILMS. Mokrousov, V. V.; Kornetov, V. N. (Moscow Power Inst.). Sov. Phys.-Solid State (Engl. Transl.); 16: No. 10, 2005(Apr 1975).

Translated from Fiz. Tverd. Tela; 16: No. 10, 3106-3107(Oct 1974).

An investigation was made of the influence of an electric field on the switching properties and electrical conductivity of VO_2 films in metal/insulator/semiconductor (MIS) structures. (DLC)

3434 ENERGY STRUCTURE OF BERYLLIUM DIBORIDE. Tupitsyn, I. I.; Lyakhovskaya, I. I.; Nakhmanson, M. S.; Sukhikh, A. S. (Leningrad State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 16: No. 10, 2015-2016(Apr 1975).

Translated from Fiz. Tverd. Tela; 16: No. 10, 3117-3119(Oct 1974).

The energy band structure of BeB_2 was calculated by the orthogonalized plane wave method; the calculations, based on 97 plane waves, were carried out on four high-symmetry points in the Brillouin zone and along the symmetric directions. The S valence subband lies next to the P subbands with no energy gap. There is no forbidden band. The P_σ conduction subband lies mostly below the P_π subband. The K x-ray emission spectra and photoelectric efficiency of B and Be in BeB_2 were measured and used to yield information on free states. (DLC)

3435 RANGE OF HOMOGENEITY OF VO_2 AND THE INFLUENCE OF THE COMPOSITION ON THE PHYSICAL PROPERTIES. I. The Preparation of Defined UO_2 and the Determination of Its Phase Boundaries. Oppermann, H.; Reichelt, W.; Gerlach, U.; Wolf, E.; Brueckner, W.; Moldenhauer, W.; Wich, H. (Central Inst. for Solid State Physics and Material Research, Dresden). Phys. Status Solidi (a); 28: No. 2, 439-446(16 Apr 1975).

VO_2 is prepared by sintering, chemical transport, and deposition in an open system; the optimal preparation conditions are given. The products, prepared by these methods, are characterized by crystallographical and chemical analysis. The upper and lower phase boundary of vanadium dioxide are determined to $VO_{2.002 \pm 0.002}$ and $VO_{1.998 \pm 0.002}$, respectively. (auth)

3436 TUNNEL EFFECT IN FILMS OF VANADIUM AND ITS OXIDES. Yanson, I. K.; Rybalchenko, L. F. (Physico-Technical Inst. of Low Temperatures, Kharkov). Phys. Status Solidi (a); 28: No. 2, 663-671(16 Apr 1975).

The tunnel junction properties of V-V_xO_y-Pb were investigated. Vanadium served as a basic film of the junctions. It was evaporated onto a glass substrate using an electron-beam heater. To form the barrier layer, vanadium was oxidized in oxygen using a glow discharge. The current-voltage characteristics of these junctions and their first and second derivatives are studied. A specific feature in the I-U characteristics is observed at energies $\Delta_{Pb} - \Delta_V$, which earlier could not be observed because of a great excess current through the junction and permits a direct measurement of the vanadium superconducting gap $2\Delta_V$ and the construction of its temperature dependence which coincides with the BKS theory with sufficient accuracy. The temperature dependence of the tunnel junction resistance is studied in a wide temperature range. The forbidden band width is measured for vanadium oxide and gives $E_g = (0.1 \text{ to } 0.3)$eV. The tunnel junctions obtained do not change their characteristics under long-term preservation at normal conditions. (auth)

3437 MOESSBAUER EFFECT OF A SINGLY SUBSTITUTED YIG SYSTEM IN AN APPLIED MAGNETIC FIELD. Piekoszewski, J. (Inst. of Nuclear Research, Swierk, Poland); Suwalski, J.; Dabrowski, L.; Makolagwa, S. Phys. Status Solidi (a); 28: No. 2, K143-K145(16 Apr 1975).

Evidence is presented for spin canting in $Y_3[Fe_{2-x}Sc_x]Fe_3O_{12}$ (x = 0, 1, 1.5) and in $YCa_2[Fe_2]FeSi_2O_{12}$. The ^{57}Fe Moessbauer spectra were taken at 4.2°K in fields of 5 to 60 kOe. (DLC)

3438 DYNAMICS OF CYLINDRICAL BUBBLE PROPAGATION IN THIN GARNET FILMS. Ilyashenko, E. I.; Kleparskii, V. G.; Yurchenko, S. E. (Inst. of Control Sciences, Moscow). Phys. Status Solidi (a); 28: No. 2, K153-157(16 Apr 1975).

Bubble propagation dynamics were studied in $Eu_{0.55}Y_{2.45}Ga_{1.2}Fe_{3.8}O_{12}$ films in a pulsed nonuniform bias. (DLC)

3439 DIFFUSION FROM IMPLANTED LAYERS WITH CONSIDERATION OF THE OUT-DIFFUSION ON THE SURFACE. Schimko, R.; Schwarz, G.; Rogge, K. (VEB Werk fuer Fernsehelektronik, Berlin). Phys. Status Solidi (a); 28: No. 2, K163-K166(16 Apr 1975).

A mathematical solution is developed for the diffusion from an implanted layer with a surface acting as a total through, a constant diffusion coefficient, and a Gaussian initial distribution. The model is applied to the diffusion of an implanted arsenic layer in SiO_2; the diffusion coefficient obtained, $1.45 \times 10^{-14} cm^2/s$ is in agreement with Drum's value. (DLC)

3440 MAGNETIC MOMENT DISTRIBUTION IN URANIUM DIOXIDE. Faber, J. Jr. (Argonne National Lab., IL). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 51-52(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

The magnetic form factor of uranium in UO_2 was examined by

means of neutron diffraction. Uranium dioxide (CaF_2 structure) orders antiferromagnetically at 30.8°K with the type I magnetic structure. The intensities of 1250 magnetic Bragg reflections (reducing to 71 independent hkl values and giving full three-dimensional data for sin theta/lambda less than or equal to 0.83 A^{-1}) were measured with a well-characterized stoichiometric single crystal at 5°K. The values of (mu f) plotted versus sin theta/lambda show considerable asphericity for sin theta/lambda greater than 0.5 A^{-1}. Comparisons with free-ion (+ crystal field) calculations give an experimental magnetic moment of 1.78 (4) mu/sub B/ and indicate that the general shape of the form factor is in agreement with theory for low scattering angles, but that the nonspherical contributions at higher angles are at least a factor of five greater than expected. The significance of these results is discussed in terms of the extended nature of the 5f wavefunctions in UO_2. (auth)

3441 X-RAY PHOTOEMISSION STUDY OF METAL-INSULATOR TRANSITIONS IN VO_2, V_2O_3, AND NiS. Wertheim, G. K.; Campagna, M.; Guggenheim, H. J.; Remeika, J. P.; Buchanan, D. N. E. (Bell Labs., Murray Hill, NJ). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 235-237(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

The x-ray photoemission density of states was obtained for a number of transition metal compounds both above and below the metal–insulator transition. In metallic VO_2, the valence band exhibits a typical metallic Fermi edge. In the insulating state the data show a approximately 0.7 eV gap below the Fermi energy. Comparison with a recent band structure calculation for the metallic state is generally satisfactory when the effects of covalent mixing are taken into account. Data for NiS confirm earlier work at lower resolution but reveal some additional structure in the d-band. No change was resolved on going through the metal-insulator transition. At room temperature in the metallic state, V_2O_3 also has a well-resolved Fermi edge. (auth)

3442 PARAMAGNETIC RESONANCE LINEBROADENING AND SPIN–SPIN RELAXATION NEAR MAGNETIC CRITICAL POINTS. Seehra, M. S. (West Virginia Univ., Morgantown); Huber, D. L. AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 261-267(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Recent studies of EPR linewidths near critical points in magnetic insulators are reviewed. Behavior of representative three-dimensional antiferromagnets $RbMnF_3$, MnF_2, $NiCl_2$, MnO, and MnS and ferromagnets EuO and $CrBr_3$ is analyzed. The connection between the EPR linewidth and the relaxation rate of the fluctuations in the total magnetization in zero field is established. Symmetry arguments are used to confirm the hypothesis that the anomalies in the EPR linewidth arise from a coupling between the fluctuations in the total magnetization and the long wavelength fluctuations in the order parameter. This coupling is induced by anisotropic terms in the Hamiltonian. The dependence of the linewidth on temperature and on the direction and magnitude of the applied field is discussed. The contribution to the linewidth coming from the spin-phonon interaction is also considered. (9 figures, 33 references) (auth)

3443 MAGNETISM IN NEPTUNIUM BORIDES. Smith, J. L.; Hill, H. H. (Los Alamos Scientific Lab., NM). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 382-383(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Magnetization measurements were performed on NpB_2, NpB_4, and NpB_{12} over the temperature range 2-180°K. NpB_2 is ferromagnetic below T/sub C/ equals 99.5 +- 2°K; NpB_4 antiferromagnetic below T/sub N/ equals 52.5 +- 2°K. These compounds exhibit approximate Curie-Weiss behavior above their ordering temperatures. The corresponding Pu compounds as well as PuB_6 were found not to exhibit magnetic ordering above 2°K. The susceptibility of NpB_{12} is relatively independent of temperature. Attempts to prepare NpB_6 in the arc furnace were unsuccessful. The ferromganetism of NpB_2 is apparently itinerant in nature, the moment being unsaturable at 52 kOe and 2°K and having magnitude approximately 0.3 mu/sub B/ per Np atom. The very occurrence of magnetism in the compound is somewhat surprising considering the relatively small separation between nearest-neighbor Np atoms in the compound, d/sub Np-Np/ equals 3.16 A. (auth)

3444 LARGE MAGNETIC EFFECT ON PHOTOTHRESHOLDS IN DOPED EuO. Eib, W.; Meier, F.; Pierce, D. T.; Ruchti, P. (Inst. of Tech., Zurich). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 401-402(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Generally, a magnetic phase transition has very little influence on photoemission. It was found that this does not apply to doped EuO, by measuring the photoelectric yield Y of pure and doped EuO single crystals up to 10 eV both above and below the ferromagnetic transition. For pure EuO the photothreshold changes only very little. In contrast, for EuO doped with approximately 1 percent La, it shifts by as much as 0.5 eV on going through T/sub c/. An interpretation of the results is attempted in terms of a change of the vacuum level of doped crystals at the magnetic phase transition. (auth)

3445 SINGLE-PHASE INHOMOGENEITY IN CERAMIC GARNETS. Levinson, L. M.; Jacobs, I. S.; Greskovich, C.; Glover, G. H. (General Electric Corporate Research and Development, Schenectady, NY). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 489-490(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Sintered ceramic garnets of composition $(Y,Gd)_3(Fe,Al)_5O_{12}$ are of technological importance for the construction of microwave phase shifters. Moessbauer spectroscopy near T/sub c/ provides a unique monitor of the effect of ceramic processing variables, as well as sintering time at temperature, on chemical homogeneity. Near T/sub c/ the coexistence of ferrimagnetic and paramagnetic phases was observed, with the width of the coexistence region, DELTA T/sub c/, varying sharply between samples. The DELTA T/sub c/ values are a quantitative measure of local chemical fluctuations, presumably in the Fe/Al ratio, which remain after the particular preparation. Roughly similar fluctuations are also inferred from x-ray line broadening, but with much less precision. Concurrent with the decrease in DELTA T/sub c/ from 9 to 3°C, the X-band resonance line width decreases from 67 to 45 Oe. This change is more than twice the maximum estimated for the observed slight decrease in porosity, and illustrates the influence of single-phase inhomogeneity on the microwave properties of substituted garnets. (auth)

3446 MAGNETIC BUBBLE PROPAGATION BY PULSED rf CURRENTS. Hubbell, W. C. (Texas Instruments Incorporated, Dallas). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 552-553(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202.

Propagation of bubbles along the edges of deposited conductors was observed. In this mode of translation, bubbles move smoothly along the perimeter of the conductor. Bubbles of 5 mu m diameter have been propagated in epitaxial films of $(Y,Sm)_3(FeGa)_5O_{12}$ with rf frequencies between 10 and 75 MHz. For pulses of 4 mu s duration, the minimum peak-to-peak rf current, I_0, required for propagation with a gold conductor 76.0 mu m wide by 1 mu m thick was found to be approximately 2 A. Propagation has been observed in both ion-implanted and non-implanted samples. Collapse field measurements indicate that bubbles capable of being propagated by this technique are not hard bubbles. (auth)

3447 $(EuTm)_3(FeGa)_5O_{12}$ GARNET FILMS WITH ONE-MICRON DIAMETER MAGNETIC BUBBLES. Giess, E. A. (IBM Research Center, Yorktown Heights, NY); Davies, J. E.; Guerci, C. F.; Hu, H. L.; Kuptsis, J. D.; Shaw, J. M. AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 582-583(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

The $(EuTm)_3(FeGa)_5O_{12}$ garnet system is particularly useful in studies of small magnetic bubbles. Physical properties change relatively slowly with the Eu/Tm ratio, and the film composition changes little with isothermal LPE growth conditions. Uniform $Eu_{0.85}Tm_{2.15}Fe_{4.45}Ga_{0.55}O_{12}$ films with 1 mu m diameter bubbles were grown on 38mm diameter substrates of GGG oriented (111). Using dilute, large volume (100 cc) melts undercooled 25°C and substrates rotated slowly (36 rpm) in a horizontal plane, the collapse field (H_0) and thickness are uniform to within 2 percent laterally across films. The temperature stability of H_0 and of domain periodicity are good up to 100°C presumably because the films have a high Curie temperature (approximately 215°C). (auth)

3448 LPE GROWTH OF GARNET FILMS UNDER ISOTHERMAL CONDITIONS FROM $PbO:B_2O_3$ BASED SOLUTIONS CONTAINING ORTHOFERRITE CRYSTALS. Plaskett, T. S.; Ghez, R. (IBM Research Center, Yorktown Heights, NY). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 584-585(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

The kinetics of isothermal growth from supersaturated solutions of composition in which the primary phase is orthoferrite is described. The film thickness increased as the square root of the growth time; the supersaturation decreased (aged) according to the Lifshitz-Slyozov theory of Ostwald ripening. The orthoferrite crystals were completely separated from the supersaturated solution at the growth temperature by a 45 mesh Pt screen for both the "dipping" and "tipping" methods. The orthoferrite was used as a source to replenish the solution in garnet constituents. The experimental data were taken on (100) $(EuY)_3Fe_5O_{12}$ films deposited on $Sm_3Ga_5O_{12}$ substrates. (auth)

3449 MAGNETOCRYSTALLINE ANISOTROPY OF Eu:YIG LPE FILMS GROWN ON (111) SUBSTRATES. Cronemeyer, D. C.; Plaskett, T. S.; Klokholm, E. (IBM Research Center, Yorktown Heights, NY). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 586-587(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

As previously reported, epitaxial films of Eu:YIG exhibit a strong dependence of the uniaxial anisotropy K/sub u/ upon Pb content. Magnetocrystalline and uniaxial anisotropies were derived simultaneously from an analysis of the FMR rotation spectra of (111) films about an in-plane [110] axis. The (111) EuIG films are grown on NdGaG, Eu_2Y_1IG films on SmGaG, and Eu_1Y_2IG and YIG films on GdGaG substrates by the LPE tipping process. The Pb contents range from 0.5 to 6 wt percent for growth temperatures ranging from 895 to 740°C. Bulk values are assumed or extrapolated for the magnetization. For EuIG, the room temperature value of K_1 is -34,000 ergs/cm^3 for zero Pb; this is decreased in magnitude by about 30 percent by a 6 wt percent Pb addition. Similar dramatic effects occur in the other members of the Eu:YIG system. In the case of YIG, the magnitude of K_1 is almost doubled by a similar addition of Pb. These changes in K_1 cannot be explained on the basis of a simple dilution model in which Pb displaces Eu or Y on the dodecahedral sites of the garnet. (auth)

3450 HIGH-SPEED PHOTOGRAPHY OF TOPOLOGICAL SWITCHING AND ANISOTROPIC SATURATION VELOCITIES IN A MISORIENTED GARNET FILM. Malozemoff, A. P. (IBM Research Center, Yorktown Heights, NY); Papworth, K. AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 593-594(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

The topological switching of a bubble array into one of the opposite polarity by a bias field pulse is studied in a garnet film ($(Eu,Y)_3(Ga,Fe)_5O_{12}$) by high-speed photography. The bubbles of the static array are elliptically distorted. When the pulse is applied, the walls move with highly anisotropic velocities, largest along the original minor axis of the bubbles in the array and smallest along the original major axis. The domain walls collide with four out of six of the nearest neighbor bubbles. At the moment the pulse terminates, the reformed array consists of dogbone-shaped domains, which later expand into an array of bubbles elliptically distorted along the original minor axis. Finally the major and minor axes interchange. The key requirement for regular topological switching is seen to be the anisotropic wall velocity. This velocity anisotropy is also observed by high-speed photography in isolated bubbles, pulsed to expand. The static ellipticity of the bubbles is related to an in-plane magnetic energy anisotropy arising from a crystallographic misorientation, and a qualitative argument shows that this same magnetic anisotropy may cause the observed velocity anisotropy. (auth)

3451 DOMAIN WALL VELOCITY DURING MAGNETIC BUBBLE COLLAPSE. Vella-Coleiro, G. P. (Bell Labs., Murray Hill, NJ). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 595-597(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Measurements of magnetic bubble collapse in a high mobility Lu Gd epitaxial garnet film have exhibited very high velocities when the bias field is made to approach the collapse field. A prominent peak in the velocity rising to approximately 10,000 cm/s is interpreted in terms of Walker breakdown. The data also imply the existence of a characteristic time for dynamic conversion to occur. This time is approximately 10 ns for our sample. (auth)

3452 VELOCITY SCATTER IN BUBBLE DOMAIN TRANSPORT MEASUREMENTS. Josephs, R. M.; Stein, B. F. (Sperry Univad, Blue Bell, PA). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 598-600(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Bubble transport measurements, in which the effect of the radial motion on the effective drive field was incorporated theoretically, have previously been described. These earlier data revealed that excessive scatter in the velocity occurred when the bubble became elliptically unstable. The more complex mechanism of "dynamic conversion" was not required to explain the scatter. In the present work, the technique was applied to ion-implanted films of $(YLaTm)_3(FeGa)_5O_{12}$ and $(YEuTm)_3(FeGa)_5O_{12}$ which have higher and lower mobilities, respectively, than the samples used previously. In each instance, the velocity data became anomalous when the bubble was in the run-out region, in agreement with previous results. The origin of the spread in velocities is shown to arise from the mechanics of the stripping-out motion. (auth)

3453 BUBBLE VELOCITIES IN $(YLa)_3(FeGa)_5O_{12}$ FILMS. de Leeuw, F. H.; Robertson, J. M. (Philips Research Labs., Eindhoven, Netherlands). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 601-602(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Bubble velocities in $(YLa)_3(FeGa)_5O_{12}$ films are measured by the two wire field gradient technique as a function of the field across the bubble (DELTA H), an in-plane field (H_I) and an initial change of strength of the bias field. At zero in-plane field a skewed motion of the bubbles at an angle of 60 to 75^0 with the direction of negative field gradient was observed. The deflection was suppressed at in-plane fields of 85 Oe and above. In these in-plane fields, it was found that the bubble velocity depends on the change of strength of the bias field at the start of the bubble motion (anti DELTA H/sub bias/). Above a critical value of anti DELTA H/sub bias/, the velocity dropped considerably. This critical value increased with increasing in-plane field. A bubble velocity of 671 m/s was observed at DELTA H equals 2.3 Oe, H_I equals 285 Oe and anti DELTA H/sub bias/ equals 0. The wall mobility was 4.6×10^4 cm s^{-1}Oe^{-1} and was in agreement with the value from straight wall oscillation experiments on similar material. (auth)

3454 DYNAMICS OF MICRON SIZE BUBBLES. Hu, H. L. (IBM Research Lab., San Jose, CA); Giess, E. A. AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 605-607(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Dynamic properties of micron diameter bubbles in garnet compositions $(EuYb)_3(FeGa)_5O_{12}$, $(EuTm)_3(FeGa)_5O_{12}$, and $(Eu)_3(FeGa)_5O_{12}$, are reported. The coercivities and mobilities of these bubbles compare very favorably with those of 5-6 micron bubbles. A mobility of 1000 cm/s/Oe was found for the composition $Eu_{0.8}Tm_{2.2}Fe_{4.5}Ga_{0.5}O_{12}$. Despite the fact that Q (the ratio of anisotropy field to the saturation magnetization) is less than 5, these films contain all kinds of soft and hard bubbles, in contrast to what Smith et al. have reported in the case of 5 micron bubbles. However, it was found that when the Q is less than or equal to 2, there exists only one kind of bubble propagating at an angle with respect to the field gradient, in accord with their observation. The micron bubbles with no Bloch lines propagate at a larger angle with respect to the direction of the field gradient than 5 micron bubbles, in qualitative agreement with Slonczewski's theory. (auth)

3455 ANNIHILATION OF BLOCH LINES IN HARD BUBBLES. Patterson, R. W. (Westinghouse Research Labs., Pittsburgh, PA). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 608-609(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

When hard bubbles are translated at sufficiently high velocities, the Bloch lines in the bubbles' walls are annihilated, resulting in soft bubbles. Investigations of this annihilation phenomenon as a function of Bloch line density were performed in YEuIG and YGdTmIG films. It was found that the velocity required to cause annihilation is inversely proportional to the Bloch line density, while the drive field required to translate the bubbles at this velocity is directly proportional to the Bloch line density. The angle theta/sub c/ between the critical velocity and the field gradient is independent of Bloch line density, and virtually invariant from sample to sample, with a value of theta/sub c/ approximately 80^0. Evidence has been found which indicates the annihilation process involves sequential destruction of Bloch lines. (auth)

3456 DYNAMIC PENETRATION OF POTENTIAL BARRIERS IN GARNET FILMS. Beaulieu, T. J.; Voegeli, O. (IBM Corpora-

tion, San Jose, CA). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 627-629(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Propagation of bubble domains by means of sequentially pulsed pairs of current conductors provides convenient wall-state discrimination by means of deflection angle. Under certain drive and bias conditions, the final bubble position is found to overshoot the potential minimum located near the pulling conductor. This unexpected result is found to be associated with localized bubble stripe-out along the edge of the pulling conductor. Drive-pulse fall time is found to be critical, with no overshoot occurring for fall times in excess of 10 mu s. Experiments were done on an LPE film of nominal composition $Eu_{0.65}Y_{2.35}Fe_{3.8}Ga_{1.2}O_{12}$. (auth)

3457 IMPROVED PROPAGATION MARGIN IN YIG COATED LPE GARNET FILMS FOR BUBBLE DEVICES. Hidaka, Y.; Yoshimi, K.; Hibiya, T.; Mikami, M. (Nippon Electric Co., Ltd., Kawasaki, Japan). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 633-634(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

YIG thin layers grown on $(Y,Eu,Yb)_3(Fe,Ga)_5O_{12}$ LPE films were found to be very effective for improvement of bubble propagation margin as well as for hard bubble suppression. In the ion-implanted rare earth substituted Ga:YIG on (111) GGG with 8 micron bubble, T-bar propagation margin was diminished, because of stretching or oscillating of bubble along the patterns. A 600 A YIG thin layer with in-plane magnetization, grown by CVD at 1065°C, obviated these destructive shortcomings and guaranteed the minimum driving field for stable bubble propagation down to 10 Oe. This improvement can be attributed to the magnetostatic interaction between the YIG layer and the bubble supporting layer. (auth)

3458 MATERIAL AND SUBMICRON BUBBLE DEVICE PROPERTIES OF $(LuSm)_3Fe_5O_{12}$. Bullock, D. C.; Carlo, J. T.; Mueller, D. W.; Brewer, T. L. (Texas Instruments Inc., Dallas). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 647-648(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

The garnet, Lu/sub x/Sm/sub 3-x/Fe_5O_{12}, with x ranging from 1.5 to 1.9, has been epitaxially grown on gadolinium gallium garnet substrates by conventional LPE dipping techniques. This range of compositions has q greater than 1 and supports submicron diameter magnetic bubbles. For an x equals 1.8 composition, the coercivity, H/sub c/, is 0.05 Oe and the anisotropy field, H/sub K/, is 4360 Oe. The wall mobility, mu, was measured by bubble translation and is 192 cm/sec-Oe for an x equals 1.5 composition. Uniform skewing but no hard bubble behavior was observed in the bubble translational studies. Magnetic bubble T-bar permalloy circuits have been fabricated by E-Beam patterning and electroplating on these films. Quasistatic bubble propagation has been observed for 0.8 mu m diameter bubbles at a drive field of 100 Oe. (auth)

3459 FIELD-DEPENDENT MAGNETIC ANISOTROPY OF SOME MIXED GARNETS WITH LIGHT RARE EARTHS. Flanders, P. J. (Univ. of Pennsylvania, Philadelphia); Egami, T.; Gyorgy, E. M.; Van Uitert, L. G. AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 666-667(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Magnetocrystalline anisotropy and magnetization were measured in mixed garnet single crystals with compositions Y/sub 3-x/R /sub x/M/sub y/Fe/sub 5-y/O_{12} (R is Nd or Sm, x from 0 to 2; M is Al or Sc, y from 0 to 1). It was found that the anisotropy and magnetization of the crystals containing Nd, Sm, and/or Sc are significantly field dependent. Results are qualitatively explained in terms of the lattice effect on the Nd and Sm magnetic moment and the moment canting due to additions of Sc. (auth)

3460 INTERPRETATION OF THE ELECTRIC CONDUCTIVITY OF ZrO_2 AND HfO_2 AT HIGH TEMPERATURE (1300°C–1600°C). Guillot, A.; Anthony, A. M. (CNRS, Orleans–Cedex, France). J. Solid State Chem.; 15: No. 1, 89-95(Sep 1975). (In French).

Ionic transport numbers have been measured for HfO_2 and ZrO_2 between 1300 and 1600°C under partial oxygen pressures varying from 1 atm to 10^{-10} atm. The ionic and electronic contributions to the total conductivity are discussed. For HfO_2, Schottky disorder agrees with the results, while, in ZrO_2, impurities seem to play an important role. (auth)

3461 PHASE TRANSITIONS IN TUNGSTEN TRIOXIDE AT LOW TEMPERATURES. Lefkowitz, I.; Dowell, M. B.; Shields, M. A. (Pitman–Dunn Lab., Philadelphia). J. Solid State Chem.; 15: No. 1, 24-39(Sep 1975).

Capacitance and electrical resistivity measurements have been made on stoichiometric and on oxygen-deficient tungsten trioxide crystals from 4.2 to 300°K. X-ray oscillation and rotation photographs were made on single crystals of both materials near 200 and 300°K. Capacitance and resistivity anomalies identify phase transitions near 40, 65, 130, 220, and 260°K in stoichiometric WO_3. Resistivity anomalies occur near 80, 130, 220, and 260°K in oxygen-deficient tungsten trioxide. Results of capacitance measurements suggest that the transformation at 130°K of a low-temperature phase of stoichiometric WO_3 is associated with a doubling of the c-parameter of the unit cell. Resistivity measurements results establish probable conduction mechanisms in each phase of stoichiometric and of oxygen-deficient tungsten trioxide, and show that oxygen-deficient tungsten trioxide undergoes a semiconductor-to-metal transition near 220°K. Electronic phenomena that do not appear to be associated with structural phase transformations are observed near 16°K in stoichiometric WO_3. (auth)

3462 EFFECT OF CRYSTAL SIZE ON CHEMICAL HYSTERESIS IN PRASEODYMIUM AND TERBIUM OXIDES. Lowe, A. T.; Lau, K. H.; Eyring, L. (Arizona State Univ., Tempe). J. Solid State Chem.; 15: No. 1, 9-17(Sep 1975).

The effect of the variation of crystal size on chemical hysteresis in phase reactions has been investigated by means of thermogravimetric analysis. Series of isobars were followed at several different pressures and crystal sizes for the PrO/sub x/–O_2 and TbO/sub x/–O_2 systems. At higher temperatures the extent of hysteresis decreased with increase in crystal size for both oxides. It was found that equilibrium was not attained in reactions occurring at lower temperatures. These experiments are contrasted with previous investigations using powdered samples. Some plausible explanations for the trends observed are discussed. (auth)

3463 SOME PROPERTIES OF GRANULAR THIN FILMS OF HIGH-FIELD SUPERCONDUCTORS. Jones, H.C. (Département de Physique de la Matière Condensée, Université de Genève, 1211-Genève 4, Switzerland). Appl. Phys. Lett. 27: No. 8, 471-473 (15 Oct 1975).

The resistance as a function of temperature, the superconducting critical temperature, and the upper critical field of NbN and Nb_3Ge thin films have been measured. These measurements may be explained in terms of a model of a granular superconductor. The properties of NbN and Nb_3Ge may be universal characteristics of high-field granular superconductors. (auth)

3464 ELECTRON LOCALIZATION INDUCED BY UNIAXIAL STRESS IN PURE VO_2. Pouget, J.P.; Launois, H. (Laboratoire de Physique des Solides, Université Paris XI, 91405 Orsay, France); D'Haenens, J.P.; Merenda, P.; Rice, T.M. Phys. Rev. Lett. 35: No. 13, 873-875 (29 Sept 1975).

NMR and EPR measurements in VO_2 under uniaxial stress in the $[110]_R$ direction lead to a phase diagram entirely similar to that obtained in $V_{1-x}Cr_xO_2$ alloys. Two intermediate phases M_2 and T are observed, and, as established for $V_{1-x}Cr_xO_2$, correspond to linear Heisenberg chains of spin 1/2 (M_2 phase) on one V sublattice. These chains undergo a progressive dimerization in the T phase as the temperature is lowered. (auth)

3465 SPIN-WAVE ANALYSIS OF SPECIFIC HEAT AND MAGNETIZATION IN EuO AND EuS. Dietrich, O.W. (Research Establishment Risø, DK-4000 Roskilde, Denmark); Henderson, A.J. Jr.; Meyer, H. Phys. Rev. B 12: No. 7, 2844-2855 (1 Oct 1975).

Recent neutron scattering measurements of the spin-wave spectrum have shown that the second-nearest-neighbor exchange constant in EuO is ferromagnetic, in disagreement with previously published results from both specific-heat and magnetization measurements. We undertook a thorough study of the bulk data on both EuO and its isomorph EuS, including some previously unpublished specific-heat data. The new analysis resolved the controversy regarding the specific heat, which is actually in good agreement with the neutron scattering results. However, the NMR data are more sensitive to effects other than the exchange energy, making this technique inferior to the two other techniques regarding determination of the exchange constants. We obtained a set of "recommended" values for the nearest- and next-nearest-neighbor exchange constants in EuO and EuS. For EuO they are $J_1/k=0.606\pm0.008$ and $J_2/k=0.119\pm0.015$; and for EuS they are $J_1/k=0.228\pm0.004$ and $J_2/k=-0.102\pm0.005$. (auth)

3466 *p-n* JUNCTION FORMATION BY Te^+ ION IMPLANTATION INTO SOLUTION-GROWN $Pb_{1-x}Sn_xTe$. Kato, Y.; Katayama, Y.; Kobayashi, K.L.I.; Komatsubara, K.F. (Central Research Laboratory, Hitachi Ltd., Kokubunji, Tokyo, Japan). J. Appl. Phys. 46: No. 10, 4614-4615 (Oct 1975).

The ion implantation of Te^+ is used to convert layers of *n*-type $Pb_{1-x}Sn_xTe$ into *p* type. A Te^+ ion concentration of greater than 1×10^{15} cm^{-2} and a suitable postanneal produce a *p*-type layer about 1 μm thick on the surface of *n*-type $Pb_{1-x}Sn_xTe$. (auth)

3467 THIN FILMS OF HAFNIUM OXIDES. Khitrova, V.I.; Kiseleva, Z.G. (Institute of Crystallography, Academy of Sciences of the USSR). Sov. Phys.—Crystallogr. 20: No. 2, 239-242 (Mar 1975).

Fast-electron diffraction has been used to examine the atomic structure of hafnium oxides; cubic and monoclinic phases exist at low and medium temperatures. Fourier analysis has given the crystal structure and composition of the low-temperature cubic modification, which has a structure of cuprite type and the composition Hf_2O. Electron diffraction of the monoclinic dioxide shows the following: 1) The crystal structure in films is exactly the same as that in macroscopic specimens; 2) the phase has a variable composition on account of partial disorder in the oxygen sublattice. This results in pseudolayering in the lattice as a whole. (auth)

3468 DIRECT ELECTROCHEMICAL REDUCTION OF CADMIUM OXIDE IN ALKALINE ELECTROLYTE. Sivaramaiah, G.; Vasudeva Rao, P. V.; Udupa, H. V. K. Trans. Soc. Adv. Electrochem. Sci. Technol.; 9: No. 4, 167-169(1974).

CdO was subjected to direct electrochemical reduction while in contact with a Ni substrate in an alkali electrolyte with a stainless steel anode in the system: metal substrate | metal oxide or hydroxide | alkaline electrolyte | anode. This is similar to the reaction which occurs during charging at the negative plate of a sintered-plate Ni/Cd battery. The reduction of CdO takes place predominantly in the solid phase. The particle size of the reduced metal is not affected by current density at alkali concentrations of <20%. At higher concentration reduction takes place both in the solid phase and by dissolution and deposition mechanisms due to the increased solubility of CdO. (Metal Abstract)

Metals and Alloys

Refer also to abstract 4661.

3469 (ORNL-TM-1200) FUELS AND MATERIALS DEVELOPMENT PROGRAM QUARTERLY PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1965. Patriarca, P. (comp.). (Oak Ridge National Lab., Tenn. (USA)). Sep 1965. Contract W-7405-eng-26. 83p. Dep. NTIS $6.00.

Activities in research programs are reported on fuel element development, mechanical properties of heat resisting alloys, nondestructive testing, zirconium metallurgy, nuclear ceramics, and radiation effects on fuel materials. (JRD)

3470 ELEKTRONNOE STROENIE I FIZICHESKIE SVOISTVA TVERDOGO TELA. Chast I. (Electron Structures and Physical Properties of Solids. Part I). Samsonov, G. V. (ed.). Kiev; Izdatel'stvo Naukova Dumka (1972). 175p.

From 7th All-Union conference on the physical properties and electron structure of transition metals, their alloys, and compounds; Kiev, USSR (1969).

A compilation of 30 articles is presented dealing with experimental studies on the thermophysical, electrophysical, optical, magnetic, galvanomagnetic, and physico-mechanical properties of the transition elements and their alloys and compounds. Separate abstracts were prepared for 8 articles. (JSR)

For abstracts of individual papers see: 3411, 3412, and 3500–3505.

Corrosion and Erosion

Refer also to abstracts 2586 and 4078.

3471 (EURFNR-1239) INCOLOY ALLOY 800: STEAM CORROSION EXPERIMENTS UNDER HEAT TRANSFER AND ISOTHERMAL STEAM CORROSION TESTING OF VARIOUS SUPERHEAT MATERIALS IN A HIGH PRESSURE LOOP. Final Report. Leistikow, S.; von Berg, H.; Jennert, D.; Erbacher, F.; Vasarhelyi, J. (Kernforschungszentrum Karlsruhe (F.R. Germany)). Dec 1974. Translation of KFK-2033. 85p. Dep. NTIS $6.00.

Work performed under United States–Euratom Fast Reactor Exchange Program.

In order to investigate superheated steam corrosion of superheated materials at high heat fluxes, a high-pressure steam loop was constructed and operated over a period of 2 years. During this time thin-walled Incoloy 800 pipe material in sealed bonding to insulated resistance heaters was subjected to steam corrosion at temperatures of 450° to 700°C and heat fluxes of 200 watts/cm^2. Under the selected conditions of exposure and exposure time no corrosion-intensifying effect was produced by the special situation of a thermally highly stressed enveloping pipe in a stepped-up, fast steam flow. Results of a number of investigations are describable by parabolic time laws and may be extrapolated to longer use times. However, allowances must be made for the unreliability of growth stresses in the metal/oxide system resulting from increasing oxide layer thickness and cyclic stresses. Cold forming operations on the surface increased the corrosion resistance of the enveloping pipes considerably. The superheated steam corrosion of the isothermally exposed sheet metal samples exhibited scarcely any corrosion-intensifying effect of dynamic high-pressure steam exposure. Coarse-grained sheet metal samples of austenitic CrNi steels oxidized substantially more than fine-grained samples while cold-worked surfaces or structures displayed a remarkable long-term stability. Excessive hydrazine additions to the feed water damaged all worked CrNi steel samples and all versions of the nickel-base alloys as a result of nickel reduction accompanied by cancellation of the protective character of the otherwise very stable Ni–Cr spinel layer. (auth)

3472 CHOICE BETWEEN CADMIUM AND ZINC PLATING FOR THE PROTECTION OF STEEL. Carter, V. E. Metal Finish. J. (London); 18: No. 213, 304-306(1972).

Literature dealing with the protection of steel by Zn and Cd is reviewed. Each of the coatings has advantages for specific corrosive environments and guidance is provided on choice of material for a particular application. Performance under accelerated corrosion conditions, in atmospheric exposure, in sea eater service, and in contact with various chemicals and vapors in enclosed spaces is compared for the two coatings. Other topics considered are bimetallic corrosion and solderability. (Corros. Abstr.)

3473 SOLUBILITY OF RH/sub 2-x/ in Gd, Er, Tm, Lu, and Y FROM AMBIENT TO 850°C. Beaudry, B. J.; Spedding, F. H. (Ames Lab., IA). Metall. Trans., B; 6B: 419-427(Sep 1975).

The solubility of hydrogen in Gd, Er, Tm, Lu, and Y was determined from 25 to 850°C when the metal was in equilibrium with RH/sub 2-x/ (x varies between 0.1 and 0.2 depending on the rare earth metal). The room temperature solubilities determined by the lattice parametric method were found to be less than 0.1, 3.6, 7.7, 20.6, and 19.0 at. percent H in Gd, Er, Tm, Lu, and Y, respectively. The change in unit cell volume for each atomic percent hydrogen added was nearly the same for all metals. The solubility of hydrogen increases more rapidly with temperature in those metals with low solubility at room temperature. Thus the solubility of hydrogen at 850°C is nearly the same in all five of the metals studied, that is, 35.0, 36.2, 36.0, 36.0, and 37.3 at. percent H in Gd, Er, Tm, Lu, and Y, respectively. The equilibrium pressure of H_2 in these studies was the equilibrium pressure of hydrogen in contact with RH/sub 2-x/ at the temperature concerned. A change in slope was observed in the solubility curves of the Gd–, Er–, Tm–, and Lu–H systems. The log C (at. percent H in R) was plotted vs 1/T for each system. Straight lines were obtained at temperatures above and below the changes in slope of the solubility curves. A calculation of the approximate DELTAH of solution of RH/sub 2-x/ in the metals from the slope of the lines gave 4.35, 1.88, 1.28, 0.61, and 0.55 kcal/mole for Gd, Er, Tm, Lu, and Y, respectively in the low temperature portion. The change in slope which occurs at some point between 350 and 650°C, depending on the metal, indicates a lower heat of solution of RH/sub 2-x/ in these metals at the higher temperatures. In Lu there appears to be yet another change in slope in the neighborhood of 250°C. (auth)

3474 OXIDATION OF STEELS IN CO_2 GAS ATMOSPHERE. Nakanishi, T. (Fuji Electric Co. Ltd., Yokosuka, Kanagawa (Japan). Central Research Lab.). FAPIG (Tokyo); No. 74, 14-21, 34(Sep 1974). (In Japanese).

The breakaway phenomenon of carbon steels including its generation mechanism, the lowering of oxidation speed of 9% Cr steel with rising temperature, and the function of oxidation resistance of Cr in austenitic stainless steel are described. The relationship between design and oxidation phenomenon is explained. Experiments were performed in the same atmospheric condition as AGR reactors, namely CO_2–2% CO–250 ppM H_2O–1,000 ppM CH_4 under 40 atm, in which various steels from carbon steel to austenitic steel were oxidized at different levels of temperature from 350° to 700°C for 10,000 hours. The materials tested were made in England as well as in Japan. Domestically produced materials were sent to England for comparison testing. Although the maximum temperature for the use of carbon steels in AGR is defined as 350°C, the thickness reduction is supposed to be only 0.7 mm after 30 years, if breakaway started from beginning. At 350°C, even several years experiment can confirm only a little example of breakaway. The generation mechanism of excrescence is not clear, but there are two relatively prominent theories at present. In conclusion, the design standard determined

in England for the oxidation-resistant steel for use in the CO_2 gas atmosphere of AGRs is believed to be correct. (JA)

3475 TENSIOSTATIC STUDY OF THE ANODIC BEHAVIOR OF TUNGSTEN IN ACID SOLUTIONS. Di Paola, A.; Di Quarto, F.; Serravalle, G. (Univ., Palermo, Italy). J. Less-Common Met.; 42: No. 3, 315-324(Oct 1975).

Tensiostatic anodization of tungsten has been studied in 1N solutions of H_2SO_4, $HClO_4$, HNH_2SO_3 and HCl at 25°C. For several voltage values, the curves of current vs. time and open-circuit voltage vs. time have been obtained. All results indicate that the oxide films produced during the polarization are slowly dissolved in the acid solutions. The HCl, and to a lesser extent the HNH_2SO_3 solutions, show a more aggressive behavior. For values of the applied voltage above about 50 V, gas evolution begins. In the case of HCl solutions, the gas is Cl_2 and the electrode is rapidly corroded. (auth)

3476 ISS DEPTH PROFILE ANALYSIS OF ANODIZED NIOBIUM. Gray, K.E. (Solid State Science Division and Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). Appl. Phys. Lett. 27: No. 8, 462-464 (15 Oct 1975).

The first several hundred atomic layers of anodized niobium were studied using ion scattering spectrometer analysis alternated with ion milling. The results show excess oxygen at the surface followed by a layer of stoichiometric Nb_2O_5. Below this was an unexpected ~ 80-Å layer of NbO and, finally, the bulk metal, with oxygen in solid solution. These results have important consequences for some ac superconducting applications since NbO is a normal metal above 1.38 K. (auth)

Preparation and Fabrication

Refer also to abstracts 4728, 4729, 4781, and 4901.

3477 (CONF-750968-2) TARGET PREPARATIONS AND THICKNESS MEASUREMENTS. Adair, H. L.; Kobisk, E. H. (Oak Ridge National Lab., Tenn. (USA)). 1975. 41p. Dep. NTIS $5.00.

From 4th annual international conference of the Nuclear Target Development Society; Argonne, Illinois, USA (29 Sep 1975).

A wide variety of isotope target preparative methods have been used, including rolling of metals, vapor deposition, electrodeposition, chemical vapor deposition, and sputtering, to obtain thin and thick films of most elements or compounds of elements in the Periodic Table. Most thin films prepared for use in self-supported form as well as those deposited on substrates require thickness measurement (atom count and distribution) and/or thickness uniformity determination before being used in nuclear research. Preparative methods are described together with thickness and uniformity determination procedures applicable to samples being prepared (in situ) and to completed samples. Only nondestructive methods are considered applicable to target samples prepared by the ORNL Solid State Division, Isotope Research Materials Laboratory. Thickness or areal density measurements of sufficient sophistication to yield errors of less than +-1 percent have been achieved with regularity. A statistical analysis procedure is applied which avoids error caused by balance zero-point drift in direct weight measurement methods. (auth)

3478 SINTERED ELECTRICAL CONTACTS. Stolarz, S. (Inst. of Non-Iron Metals, Gliwice, Poland). Sci. Sintering; 7: No. 2, 169-178(May 1975).

Results of a study of sintered electrical contact materials of the types tungsten–silver, tungsten–copper–nickel, silver–nickel silver–graphite and silver–cadmium oxide are presented. During their preparation, powder metallurgy methods were used, e.g., pressing of powder mixtures and sintered semi-products, impregnation of porous tungsten carcasses in hydrogen atmosphere, and vacuum and plastic deformation of sintered intraoxidized materials. (auth)

3479 METAL DEPOSIT THICKNESS CALIBRATION STANDARD. Rivassou, Yves. (to Radiall, 75 - Paris (France)). French Patent 2,207,593/A/. 20 Nov 1972. 5p. (In French)

Available from Institut National de la Propriete Industrielle, Paris (France).

The calibration standard comprises a spherical support coated with a metal layer of constant thickness. The layer is deposited electrolytically or chemically while the support is brought to a large number of positions about its center. This standard permits apparatus adapted to measure thicknesses, in particular through back-scattering or by means of x rays, to be calibrated. (FR)

3480 POWDER APPROACH FOR MULTIFILAMENTARY NIOBIUM-TIN SUPERCONDUCTING WIRE. Hemachalam, K.; Pickus, M.R. (Inorganic Materials Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Appl. Phys. Lett. 27: No. 10, 570-571 (15 Nov 1975).

Based on powder-metallurgy techniques, a process to fabricate Nb_3Sn multifilamentary superconducting wire is described. The current-carrying capacity of the wire was above 2×10^5 A/cm² at a steady transverse magnetic field of 50 kG and about 1×10^5 A/cm² at 100 kG. (auth)

3481 PREPARATION OF THIN ACTINIDE METAL DISKS USING A MULTIPLE DISK CASTING TECHNIQUE. Conner, W. V. (Dow Chemical U.S.A., Golden, CO). J. Less-Common Met.; 42: No. 3, 303-310(Oct 1975).

A casting technique has been developed for preparing multiple actinide metal disks which have a minimum thickness of 0.006 inch. This technique was based on an injection casting procedure which utilizes the weight of a tantalum metal rod to force the molten metal into the mold cavity. Using the proper mold design and casting parameters, it has been possible to prepare ten 1/2-inch diameter neptunium or plutonium metal disks in a single casting. This casting technique is capable of producing disks which are very uniform. The average thickness of the disks from a typical casting will vary no more than 0.001 inch and the variation in the thickness of the individual disks will range from 0.0001 to 0.0005 inch. (auth)

3482 FORMATION OF SECONDARY β-TUNGSTEN. Neugebauer, J. Acta Tech. Acad. Sci. Hung.; 78: No. 3/4, 279-282(1974).

A study of the reduction of tungsten bronzes and potssium tungsten bronzes indicated that secondary β-W can be formed from tetragonal potassium tungsten as well as from WO_2. The K acts as a catalyst and the bronze is a transient compound of the catalytic process. (Metals Abstr.)

3483 PRODUCTION OF TUNGSTEN BY THE ELECTROLYSIS OF MOLTEN MEDIA. Imamov, T. Kh.; Bazarov, R. N.; Kal'kov, A. A. Elektrokhimiya; 10: No. 8, 1223-1225(Aug 1974). (In Russian).

A reduction cell is described for the production of W from a molten electrolyte containing mixture of scheelite ($CaWO_4$) with NaCl, and $NaPO_3$. The W powder obtained had a purity of 99.2%, while metallic impurities such as Ba, Cu, Cr, and Zn were not detected. Over the temperature range 910 to 1100°C the best current efficiency was obtained at 1050°C; increasing the temperature to 110°C reduced this to 38%. The maximum current efficiency of 60% was obtained with electrolytes containing scheelite 7%, at an initial current density of 3000 A/m². Addition of NaF 5 wt.-% to the electrolyte increased the solubility of scheelite to 10 wt.-%, and from this mixture fine dendrities of W were obtained at a current efficiency of 41% and a cathodic current density of 7500 A/m². (Metals Abstr.)

3484 INHIBITING ACTION OF ADDITIVES IN THE ELECTRODEPOSITION OF CADMIUM. Loshkarev, Yu. M.; Rysakov, A. A.; Litovka, G. P. Elektrokhimiva; 10: No. 10, 1597-1599 (Oct 1974). (In Russian).

A study was made of the effect of surface-active additives and supporting anions on the electroreduction of Cd^{2+} using galvanostatic polarization curves. Data were obtained on the reduction of Cd^{2+} ions from sulfate solutions containing tetrabutyl NH_4 ions or benzoylpiperdine ions and from chlorate solutions containing benzoylpiperidine ions. From the nature of the potential charge with time it was estimated that the formation of a complete absorbed layer takes place almost instantaneously. The magnitude of the potential jump corresponds to the positive overvoltage necessary for the penetrating ions to be discharged through the absorbed layer. (Metals Abstr.)

3485 HOW TO MACHINE BERYLLIUM COPPER. Wikle, K. G.; Harlan, C. B. Am. Mach./Metalwork. Manuf.; 119: No. 6, 75-86(15 Mar 1975).

In the machining of Cu–Be alloys problems of work hardening, age hardening, abrasiveness and part distorsion are met by deep cuts (0.007 in. or more) using proper tool shape and rigidity and ample cutting fluid. Recommendations are made for turning, drilling, reaming, tapping, milling, sawing, and grinding of alloys (using the unified numbering system) classified as: free cutting (machinability rating 100 (which equals free cutting brass) to 60) C36000, C34200, C18700, C79800, C34000, C17700, C33500, C17300; moderately machinable (M. R. 60 to 30) C63900, C28000, C17500, C82000, C17600, C81800, wrought BeCu in hot worked temper, cast BeCu as-cast or solution treated or annealed, C23000, C27000; more difficult to machine (MR 20) C11000, C51000, C61400, C71500, C75000, wrought BeCu cold drawn or solution treated; and most difficult to machine (M. R. 20 to 10) high-strength BeCu as cast and age hardened, annealed and age hardened, and work hardened and age hardened. Grinding, welding and joining of Be bearing materials are subject to safety and health regulations. (Metals Abstr.)

3486 WELDING NUCLEAR VALVES. Parkinson, G. Am. Mach./Metalwork. Manuf.; 119: No. 6, 87(15 Mar 1975).

By machining small forgings that are then welded to form the large valve (up to 24-in. pipe dia.) the delivery time is 180 days compared with 18 months required for T-valves machined from one-piece forgings. The cost is about the same by each method. The welded valve bodies meet ASME specifications for power plant valves. The large valve bodies are made by butt welding two pieces of heavy walled tubing to form the passage of the T, machining a gate hole and adding a valve neck by a saddle weld around the gate hole. (Metals Abstr.)

Properties, Structure, and Phase Studies

Refer also to abstracts 2683, 2687, 3463, 3643, 3980, 4274, 4275, 4279, 4281–4283, 4698, 4780, and 4819.

3487 (AECL-5176) REFINEMENT OF THE Zr/Zr_3Al DUPLEX STRUCTURE IN Zr-7.6 TO -9.0 WT % Al INGOTS. Schulson, E. M.; McColl, D. H.; Ling, V. C. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Jul 1975. 18p. Dep. NTIS (US Sales Only) $4.50. AECL $0.50.

Zirconium–aluminum ingots of compositions bracketing Zr_3Al (8.97 wt% Al) are characterized by a nonequilibrium duplex mixture of Zr_2Al precipitates and a transformed β-zirconium matrix containing Al in solution. Within large commercial ingots the Zr_2Al particle size is of the order of 3-4 μm and larger, depending on ingot size. A heat-treatment method is described which allows the particles to be reduced to 0.3 to 0.4 μm in diameter, thereby increasing by at least an order of magnitude the velocity of the peritectoid transformation $Zr + Zr_2Al \rightarrow Zr_3Al$. Problems and limitations are discussed. (7 fig) (auth)

3488 (HEDL-SA-925) SOME QUESTIONS REGARDING THE INTERACTION OF CREEP AND FATIGUE. James, L. A. (Westinghouse Hanford Co., Richland, Wash. (USA)). Apr 1975. Contract AT(45-1)-2170. 20p. (CONF-751106-2). Dep. NTIS $4.50.

From annual meeting of ASME; Houston, Texas, USA (30 Nov 1975).

Data are presented from fatigue-crack growth tests conducted on Type 304 S.S. in inert environments at elevated temperatures which show that the thermal-activation noted in similar tests run in air environments is not present in the inert environment. Similar observations from the literature are reviewed, including the observation that the time-dependency noted in tests conducted in elevated temperature air environments is also greatly suppressed in inert environments. These findings suggest that an interaction between the fatigue process and the corrosive air environments is responsible for the thermally activated time-dependent behavior often attributed to creep-fatigue interaction. Data are also presented which show that the fatigue-crack growth behavior of Type 304 S.S. subjected to significant creep damage prior to fatigue testing does not differ appreciably from the behavior of material not subjected to prior creep damage, again indicating minimal interaction between creep and fatigue. It is suggested that in the temperature range where pressure vessels and piping are generally designed to operate (i.e. below about one-half the absolute melting temperature of the alloy), the interaction between creep and fatigue is far less significant than once supposed, and that the major parameter interacting with the fatigue process is that of high-temperature corrosion. (39 references, 12 fig) (auth)

3489 (N-75-17476) EUTECTIC SUPERALLOYS BY EDGE-DEFINED, FILM-FED GROWTH. Hurley, G. F. (Tyco Labs., Inc., Waltham, Mass. (USA)). Jan 1975. Contract NAS3-16790. 83p. (NASA-CR-134756). NTIS $4.75.

The feasibility of producing directionally solidified eutectic alloy composites by edge-defined, film-fed growth (EFG) was carried out. The three eutectic alloys which were investigated were gamma + delta, gamma/gamma prime + delta, and a Co-base TaC alloy containing Cr and Ni. Investigations into the compatibility and wettability of these metals with various carbides, borides, nitrides, and oxides disclosed that compounds with the largest (negative) heats of formation were most stable but poorest wetting. Nitrides and carbides had suitable stability and low contact angles but capillary rise was observed only with carbides. Oxides would not give capillary rise but would probably fulfill the other wetting requirements of EFG. Tantalum carbide was selected for most of the experimental portion of the program based on its exhibiting spontaneous capillary rise and satisfactory slow rate of degradation in the liquid metals. When a stream of helium was directed against the side of the bar during growth, the thermal gradient was found to improve to about 250°C/cm. In comparison, a theoretical gradient of 700°C/cm should be possible under ideal conditions, without the use of chills. Methods for optimizing the gradient in EFG are discussed. These methods should allow attainment of close to the theoretical for a particular configuration. (auth)

3490 (NMI-7020-2) EFFECT OF HEAT TREATMENT ON THE PROPERTIES OF HIGH-URANIUM ALLOYS. Anderson, R. W. (Nuclear Metals, Inc., Concord, Mass. (USA)). 27 Mar 1964. 52p. Dep. NTIS $5.50.

Declassified 29 Nov 1973.

Effects of various heat treatments on the hot-hardness and microstructure of three high-uranium alloys were studied to aid in the specification of the composition and thermal history of fuels capable of improved irradiation behavior. It was found that the alloy additions (up to 350 ppM Fe, Si, and Al) cause a precipitation hardening system; that is, the alloy additions can be taken into solution at high temperatures and then precipitated as fine particles at lower temperatures. Hot-hardness and metallographic data were obtained concerning the effects of solution temperatures, quenching rates from solution temperatures, and time-temperature relationships necessary for precipitation of the alloy phases. 25 fig. (auth)

3491 (ORNL-5050, pp 70-71) ACTINIDE OXIDES, NITRIDES, AND CARBIDES. Oct 1975.

In Chemical Technology Division annual progress report for period ending March 31, 1975. (Oak Ridge National Lab., Tenn. (USA)).

In compatibility studies, the possibility of q forming Laves-phase compounds with uranium (A component) and combinations of chromium with iron or nickel (B component) was investigated. Results confirm that compounds of the type U(Fe/sub x/Cr/sub $1-x/)_2$ do exist and that they have the C15 Laves-phase structure. (LK)

3492 (ORNL-5088) INVESTIGATION OF ALLOYING EFFECTS IN ALUMINUM DISPERSION STRENGTHENED WITH Al_2O_3. Copeland, G. L. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 112p. Dep. NTIS $5.45.

Two types of alloying elements were investigated to determine if the room-temperature strength could be improved and if, through lowering the oxide content, the high-temperature ductility could be improved. Mg was investigated for its solid solution strengthening in one type alloy. The other type alloy involved further dispersion strengthening through adding Fe, Mo, Zr, Cr, V, and Ti which form highly stable intermetallic compounds with Al. Fabrication techniques were developed which produced uniform and reproducible rods for testing. Prealloyed powders were produced by atomizing the molten alloys and collecting the powders in water. This procedure produced uniform powders with a very fine distribution of the intermetallic compounds. Fabrication into rods then included ball-milling, vacuum hot pressing, vacuum heat treating, and hot extrusion. Mg additions improved strengths up to 200°C with little effect above that temperature. Room-temperature tensile strengths up to 77,000 psi were obtained which are comparable to the strengths obtained in conventional aluminum alloys. The additional dispersion strengthening of the intermetallic compounds is additive to that of the oxide from room temperature to 450°C. No significant improvements in ductility are obtained by reducing the oxide content since even at very low ball-milling times (i.e., low oxide contents) the uniform elongation at 450°C is typically 0.5 percent. Good combinations of strength and ductility at 450°C were obtained in some of the alloys containing intermetallic compounds with no ball-milling. Typical properties at this temperature were tensile strengths of 7,000 psi, uniform elongation of 3 percent, and total elongation of 35 percent. (21 tables, 33 fig, 43 references) (auth)

3493 (RD/B/N–3235) DETERMINATION OF THE THRESHOLD FOR FATIGUE CRACK PROPAGATION USING A NOVEL RANDOM AMPLITUDE GROWTH TECHNIQUE. Priddle, E. K. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Jun 1975. 16p. Dep. NTIS (US Sales Only) $4.25.

The results of a limited investigation into a novel method for the determination of the threshold for fatigue crack propagation are presented. This method offers a possible solution to the ΔK_0 problem in difficult environments such as high temperature liquid sodium where, although the general growth laws are known, crack length measurement techniques are too insensitive to determine initiation of slow growth over long periods. Results of ΔK_0 for EN3A mild steel and AISI 316 stainless steel agree with published data for laboratory air at ambient temperature. For an alternator conductor copper the results are inconclusive and for an EN24 steel are consistently higher than published data. It is thought that the method shows promise as a means of obtaining ΔK_0 information in difficult environments and will receive further attention. (auth)

3494 (RISO-329) STEADY-STATE CREEP OF DISCONTINUOUS FIBER COMPOSITES. Pedersen, O. B. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jul 1975. 74p. Dep. NTIS (US Sales Only) $5.50.

Thesis. Submitted to Technical Univ. of Denmark, Lyngby.

A review is given of the relevant literature on creep of composites, including a presentation of existing models for the steady-state creep of composites containing aligned discontinuous fibers where creep of the matrix and fibers is assumed to follow a power law. A model is suggested for predicting the composite creep law given in a general form, in the case where the fibers do not creep. The composite creep law predicted by this model is compared with those predicted by previous models when these are extended to comprise a general matrix creep law. Experimentally, pure copper and composites consisting of aligned discontinuous tungsten fibers in a copper matrix were creep tested at a temperature of 500°C. The results indicate a relatively low stress sensitivity of the steady-state creep-rate for pure copper and a relatively high stress sensitivity for the composites. This may be explained by the creep models based upon a general matrix creep law. A quantitative prediction shows promising agreement with the present experimental results. (auth)

3495 (RISO-M-1810) PREDICTION OF THE CREEP PROPERTIES OF DISCONTINUOUS FIBER COMPOSITES FROM THE MATRIX CREEP LAW. Bilde-Soerensen, J. B.; Pedersen, O. B.; Lilholt, H. (Danish Atomic Energy Commission, Risoe. Research Establishment). Feb 1975. 22p. Dep. NTIS (US Sales Only) $4.50.

Existing theories for predicting the creep properties of discontinuous fiber composites with non-creeping fibers from matrix creep properties, originally based on a power law, are extended to include an exponential law, and in principle a general matrix law. An analysis shows that the composite creep curve can be obtained by a simple displacement of the matrix creep curve in a log σ vs. log $\dot{\varepsilon}$ diagram. This principle, that each point on the matrix curve has a corresponding point on the composite curve, is given a physical interpretation. The direction of displacement is such that the transition from a power law to an exponential law occurs at a lower strain rate for the composite than for the unreinforced matrix. This emphasizes the importance of the exponential creep range in the creep of fiber composites. The combined use of matrix and composite data may allow the creep phenomenon to be studied over a larger range of strain rates than would otherwise be possible. A method for constructing generalized composite creep diagrams is suggested. Creep properties predicted from matrix data by the present analysis are compared with experimental data from the literature. (auth)

3496 (SAND-75-0362) SHORT-TIME, HIGH TEMPERATURE MECHANICAL TESTING OF ELECTRICALLY CONDUCTIVE MATERIALS. Marion, R. H.; Karnes, C. H. (Sandia Labs., Albuquerque, N. Mex. (USA)). Oct 1975. Contract AT(29-1)-789. 51p. Dep. NTIS $5.45.

Design and performance details are given for a facility which was developed to obtain the mechanical properties of materials under high heating rate or transient temperature conditions and medium strain rates. The system is shown to be applicable to materials possessing electrical resistivities ranging from that of aluminum to that of graphite without taxing the heating capability. Heating rates as high as 2000°K/s in graphite are attained under controlled conditions. Methods of measuring temperature and the effects of expected temperature distributions are discussed. A method for measuring strain valid for transient temperature conditions to 3000°K is described. Results are presented for the stress-strain behavior of 316 stainless steel and ATJ(S) graphite obtained for heating times of a few seconds. (auth)

3497 (SAND-75-5696) NOTCH CONSTRAINT EFFECTS ON THE DYNAMIC FRACTURE TOUGHNESS OF AN UNAGED BETA TITANIUM ALLOY. Rack, H. J. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1975. 18p. Dep. NTIS $4.50.

The influence of notch included angle and root radius on the apparent dynamic fracture toughness of an unaged metastable beta titanium alloy, Ti-3Al-8V-6Cr-4Zr-4Mo, has been examined. The apparent fracture toughness, K/sub Id/(rho), increases with both notch radius, rho and included angle, omega. These results have been compared with the theoretical predictions of Tetelman, et al, and Smith. The comparisons show that neither theory accurately describes the effect of varying notch constraint on the apparent dynamic fracture toughness. Although preliminary considerations indicate that qualitative descriptions of notch acuity effects may be given by recent finite element analysis of the stress and strain distributions below a notch root, there is presently no quantitative basis for determining the true dynamic fracture toughness of materials from the results of blunt notch experiments. (auth)

3498 (VTT-REA-28) AUTORADIOGRAPHIC DETERMINATION OF THE DISTRIBUTION IN SOME LOW-ALLOYED STEELS. Vilpponen, K. O; Salmela, A. E. (Valtion Teknillinen Tutkimuskeskus, Otaniemi (Finland). Reaktorilaboratorio). Feb 1974. 16p. Dep. NTIS (US Sales Only) $4.00.

The $^{10}B(n,\alpha)^{7}Li$ reaction was used to determine the distribution of boron in the microstructure of a few steels. Microscopy was involved in the examination of detector foils containing tracks related to boron. The technique for the preparation of specimens for optical as well as electron microscopy is considered in some detail. The work is mainly concerned with the role of boron in promoting creep resistance in low-alloyed steels. It is shown that optimum creep properties are obtained when boron is associated with precipitation. Segregation of boron to austenite grain boundaries appears to be a very common phenomenon in the steels studied. Zones depleted of boron were observed in some cases in the vicinity of the boundaries. (auth)

3499 (WARD-NA-3045-27) SODIUM TECHNOLOGY PROGRAM: FRICTION, WEAR, AND SELF WELDING. Quarterly Progress Report for Period Ending April 30, 1975. Ray, W. E. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Oct 1975. Contract E(11-1)-3045. 98p. AT.

Activities in research programs are reported on friction and wear of reactor materials in liquid Ha, self welding of reactor materials in liquid Na, and compatibility of low-friction materials in liquid Na. (JRD)

3500 ANOMALIES IN THE PHYSICAL PROPERTIES OF ALPHA TITANIUM AND ALPHA ZIRCONIUM. Bykov, V. N.; Rudnev, I. I.; Solov'ev, V. A. (Physical Energy Inst., Obninsk, USSR). pp 42-47 of Elektronnoe Stroenie i Fizicheskie Svoistva Tverdogo Tela. Chast I. Samsonov, G. V. (ed.). Kiev; Izdatel'stvo Naukova Dumka (1972). (In Russian)

From 7th All-Union conference on the physical properties and electron structure of transition metals, their alloys, and compounds; Kiev, USSR (1969).

The electrical conductivity of titanium and zirconium was studied from 0 to 1000°C. Measurements of electrical resistance were carried out by a potentiometric method with an accuracy of 0.5% in a vacuum of 10^{-4} mm Hg std. A temperature dependence for the specific electrical resistance was derived according to a two-zone model of Sundheimer with current carriers of both signs being present in the metals. (SJR)

3501 STUDY OF THE DYNAMICS OF ^{119}Sn IMPURITY ATOMS IN SOLID SOLUTIONS OF Ti-Sn AND V-Sn BY MEANS OF THE MOESSBAUER EFFECT. Balkashin, O. P.; Chekin, V. V. (Physical-Technical Inst. of Low Temperatures, Kharkov). pp 86-89 of Elektronnoe Stroenie i Fizicheskie Svoistva Tverdogo Tela. Chast I. Samsonov, G. V. (ed.). Kiev; Izdatel'stvo Naukova Dumka (1972). (In Russian)

From 7th All-Union conference on the physical properties and electron structure of transition metals, their alloys, and compounds; Kiev, USSR (1969).

This study reports the temperature dependency for the probability of resonance absorption on ^{119}Sn nuclei in solid solutions of Ti-Sn (1 and 5 at. % Sn) and V-Sn (1 and 10 at. % Sn). The resonance absorption spectra were taken on a mechanical setup having a constant velocity. An alloy of ^{119}Sn with Pd was used as the source of resonance gamma quanta. The source was maintained at the temperature of liquid nitrogen. The temperature of the absorbing material was varied from 70 to 600°K and was maintained with an accuracy of 0.5°. Values of the probability of recoilless absorption were calculated from the area of the resonance peak. Values for the probability of resonance absorption at 78°K were found to be: 0.74 ± 0.02 for a V alloy with 1 at. % Sn; 0.56 ± 0.02 for a V alloy with 10 at. % Sn; 0.72 ± 0.02 for the Ti alloy with 1 at. % Sn, and 0.66 ± 0.02 for the Ti alloy with 5 at. % Sn. The probability of the effect decreases with increasing concentration of impurity. Apparently this behavior is associated with a decrease in the force constants of the interaction between impurity and matrix atoms and by a displacement of the frequency distribution of the oscillations of impurity atoms towards the low-frequency region of the phonon spectrum. (SJR)

3502 OPTICAL PROPERTIES OF MOLYBDENUM FILMS. Nesmelov, E. A.; Belashova, L. V.; Orlova, L. G. pp 94-98 of Elektronnoe Stroenie i Fizicheskie Svoistva Tverdogo Tela. Chast I. Samsonov, G. V. (ed.). Kiev; Izdatel'stvo Naukova Dumka (1972). (In Russian)

From 7th All-Union conference on the physical properties and electron structure of transition metals, their alloys, and compounds; Kiev, USSR (1969).

Molybdenum films were obtained by electron bombardment evaporation in vacuum onto glass and quartz backings. The refractive index η and the extinction coefficient k were measured as a function of film thickness. At a film thickness h of 0.0432 Å, the change in values of η and k were 0.63 and 1.344 at a wavelength λ of 0.25 microns, 0.610 and 1.883 at $\lambda = 0.5\ \mu$, 0.866 and 2.299

at $\lambda = 0.75\ \mu$ and 1.243 and 2.534 respectively at $\lambda = 1.0\ \mu$. For a film thickness of 0.07 Å, the change in values of η and k were 1.594 and 1.717 at $\lambda = 0.25\ \mu$, 1.631 and 1.843 at $\lambda = 0.5\ \mu$, 1.819 and 2.140 at $\lambda = 0.75\ \mu$, and 1.689 and 2.678 at $\lambda = 1.0\ \mu$. For a film thickness of 0.1158 Å, the change in the refractive index η and the extinction coefficient were 1.171 and 1.834 calculated at a wavelength $\lambda = 0.25\ \mu$, 1.912 and 2.332 at $\lambda = 0.5\ \mu$, 2.240 and 2.545 at $\lambda = 0.75$ microns and 2.710 and 2.819 at $\lambda = 1.0\ \mu$. Formulas are given for calculating the optical constants of the molybdenum films. (SJR)

3503 ELECTRONIC CHARACTERISTICS OF SPUTTERED ALLOYS OF VANADIUM WITH GALLIUM OBTAINED BY MEASURING THE OPTICAL PROPERTIES OF THESE ALLOYS AND A SERIES OF OTHER PROPERTIES. Golovashkin, A. I.; Levchenko, I. S.; Motulevich, G. P. (Inst. of Physics, Moscow). pp 99-103 of Elektronnoe Stroenie i Fizicheskie Svoistva Tverdogo Tela. Chast I. Samsonov, G. V. (ed.). Kiev; Izdatel'stvo Naukova Dumka (1972). (In Russian)

From 7th All-Union conference on the physical properties and electron structure of transition metals, their alloys, and compounds; Kiev, USSR (1969).

By an optical method, a study was made of the electronic characteristics of a series of superconducting metals and alloys in order to investigate the possible correlation of electronic characteristics with the superconducting parameters of real metals and alloys. Vanadium and gallium were simultaneously evaporated in vacuum from various evaporators onto polished sapphire backings. Temperature of the backing during evaporation was 500 to 600°C, and during annealing for 1 to 2 h the temperature was 700 to 800°C. A total of 16 samples were prepared with compositions containing from 3 to 80 wt % gallium. A number of characteristics were measured on these samples: optical properties at T = 293 and 78°K, transition temperature to the superconducting state T_c, critical current density j_c, static conductivity and its dependence on temperature, and the density ρ. The density and lattice constants correspond to a composition V_3Ga. The maximum critical temperature $T_F = \sim 14$°K corresponded to a concentration of conductivity electrons $N = 2.2 \times 10^{22}$ cm^{-3}, a total area of the Fermi surface $S_F = 1.6 \times 10^{-37}$ g-cm^2/s^2, and an average velocity of electrons on the Fermi surface $V_F = 0.65 \times 10^8$ cm/s. (SJR)

3504 MASS-SPECTROMETRIC INVESTIGATION OF THE ION-ION EMISSION OF PURE METALS. Vasil'ev, M. A.; Ivashchenko, Yu. N.; Cherepin, V. T. (Inst. of Metal Physics, Kiev). pp 103-107 of Elektronnoe Stroenie i Fizicheskie Svoistva Tverdogo Tela. Chast I. Samsonov, G. V. (ed.). Kiev; Izdatel'stvo Naukova Dumka (1972). (In Russian)

From 7th All-Union conference on the physical properties and electron structure of transition metals, their alloys, and compounds; Kiev, USSR (1969).

This study deals with the systematic investigation of ion emission from pure metals in order to establish the relative intensity of metal ion emission. The metal targets were sputtered by a beam of positive, 6-keV argon ions at a primary current density of 0.6 mA/cm^2. Secondary ion currents were recorded by an electrometric amplifier and potentiometer EPP-09. Stable values of secondary ion currents in amps $\times 10^{-13}$ for various metals were found to be: 5400 for Al, 1700 for Ti, 440 for Mo, 420 for V, 320 for Cr, 310 for Be, 150 for Zr, 140 for Ge, 130 for Nb, 78 for W, 72 for Fe, 60 for Si, 48 for Ni, 39 for Co, 39 for Ta, 19 for Cu, 16 for Pd, 5.4 for Zn, 5.1 for Sb, and 2.4 for Sn. It is shown that elements with a great affinity for oxygen give a high yield of secondary ions. (SJR)

3505 MODIFYING VACUUM-MELTED MOLYBDENUM WITH BORON. Chenov, V. S.; Busol, F. I.; Nam, B. P. (All-Union Scientific-Research Inst. of Material Electron Technology, Kaluga, USSR). pp 108-112 of Elektronnoe Stroenie i Fizicheskie Svoistva Tverdogo Tela. Chast I. Samsonov, G. V. (ed.). Kiev; Izdatel'stvo Naukova Dumka (1972). (In Russian)

From 7th All-Union conference on the physical properties and electron structure of transition metals, their alloys, and compounds; Kiev, USSR (1969).

The effect of small boron additions (0.001 to 0.1 wt %) on the structure and properties of vacuum-melted molybdenum was investigated. Macrostructure studies showed that boron at contents greater than 0.007% shows a refinement in grain size of Mo with the greatest refinement in grain size occurring at 0.01 to 0.02 wt % boron. The presence of carbon (up to 0.1%), titanium, zirconium, niobium, and tantalum (up to 0.5%) has no effect on the refining of the grain size of Mo. Boron can also be added in the form of LaB_6 or TiB2. The most probable reasons for the modification of molybdenum by boron is the accumulation of boron at the crystallization front, and also a possible electronic interaction between melt components which leads to a change in melt structure. (SJR)

3506 REFRACTORY METALS TUNGSTEN, MOLYBDENUM, AND TANTALUM. Sedlatschcek, K. (Metallwerk Plansee AG, Reutte, Austria). Sci. Sintering; 7: No. 2, 179-186(May 1975).

Preparation and properties of Mo, W, and Ta alloys and compounds for electronics applications are reviewed. Information and data are presented on mechanical properties, applications and preparation technology. (JRD)

3507 STEELS FOR HOT WORKING BOLTS AND NUTS. Cazin, Y. (Societe Creusot-Loire, 75 - Paris (France)). Mater. Tech.; 63: No. 3, 77-84(Mar 1975). (In French)

From 1st colloquium on bolting and metallurgy of iron; Lyon, France (17 Apr 1975).

Bolts and nuts suffer from stresses and strains affecting the various properties of the metal. Analysis of those characteristics had led to a choice of steel selected according to such criteria as: high temperature strength; longtime creep and relaxation; resistance to oxidation; stability of characteristics and structure; and expansion ratio. The various grades of steel normally used are: Cr-Mo-V engineering steels; high chromium stainless steels; Cr-Ni and Cr-Ni-Mo austenitic alloys; nickel base alloys. Hot creep is controlled by structural mechanisms ruled by the chemical composition and the heat treatments. The resulting characteristics allow a large range of temperature to be covered. Practical examples illustrate these basic data. (FR)

3508 ELECTRICAL RESISTIVITY OF SOME LIQUID CADMIUM ANTIMONY ALLOYS AS A FUNCTION OF TEMPERATURE. Gasser, J. G.; Kleim, R. (Metz Univ., 57 (France)). J. Phys. (Paris), Lett.; 36: No. 4, L.93-L.95(Apr 1975).

The electrical resistivity of several $Cd_{1-x}Sb_x$ antimony rich alloys was investigated between the liquidus curve and about 900°C. The sharp decrease in the resistivity, which occurs after the melting, is discussed in terms of clusters. Above 800°C, the resistivity becomes an increasing function of temperature. (FR)

3509 ATOM TRANSPORT PHENOMENA IN LIQUID INDIUM-LEAD ALLOYS. Rialland, J. F.; Robert, J. (Paris-6 Univ., 92 - Fontenay-aux-Roses (France). Lab. de Genie Electrique). J. Phys. (Paris), Lett.; 36: No. 4, L.89-L.91(Apr 1975). (In French)

A hard sphere model was used to interpret atomic transport processes in indium-lead alloys. The experimental data lead to hard core diameters of 3.04Å for indium and 3.40Å for lead. The distances between the origin and the first minimum of the pair potential curves are 3.1 and 3.3Å for indium and lead, respectively. Thus, within the accuracy of the data, the results obtained from theory and experiment are in good agreement. (FR)

3510 NORMAL AND OBLIQUE TRANSMISSION OF NIOBIUM THIN FILMS FROM 0.32 TO 5.50 eV. Sigrist, Maurice; Chassaing, Gerard; Gravier, Pierre; Pierrisnard, Roger (Aix-Marseille-1 Univ., 13 - Marseille (France)). C. R. Hebd. Seances Acad. Sci., Ser. A, B; 280: No. 13, 413-416(7 Apr 1975). (In French)

The optical transmission variations of niobium thin films were studied. An important absorption band, which lies between 1.6 to 5.5 eV, was noted. The results obtained are similar to those found for vanadium but offset to the ultraviolet. Especially, the minimum transmission displacement is about 1.5 eV. (FR)

3511 FIRST ORDER TRANSITIONS IN ACo_2 COMPOUNDS. Bloch, D.; Edwards, D. M.; Shimizi, M.; Voiron, J. (CNRS, Grenoble, France). J. Phys., F (London); 5: No. 6, 1217-1226 (Jun 1975).

Some magnetic properties of ACo_2 compounds, where A is a heavy rare earth metal, are shown to be related to properties of YCo_2. In particular the existence of first order transitions for A = Er, Ho, Dy, but second order transitions for A = Tb, Gd, implies a special temperature dependence of the Landau parameter B which appears in the expansion of the free energy of YCo_2 in powers of the magnetization. B changes from negative to positive with increasing temperature and this is verified experimentally by measurements of the field dependence of the susceptibility of YCo_2 at 4.2, 77 and 300°K in field up to 150 kOe. It is estimated that an applied field of about 1400 kOe would be required to produce itinerant electron metamagnetism in YCo_2 and the magnetization of $Gd_xY_{1-x}Co_2$, where the applied field is the molecular field due to Gd moments, is discussed from this point of view. Stoner theory is used to relate the behavior to B to the existence of a maximum in the susceptibility of YCo_2 as a function of temperature. (auth)

3512 X-RAY L-FLUORESCENCE SPECTRA OF NIOBIUM IN NIOBIUM METAL AND SOME OF ITS COMPOUNDS. II. Bahl, M. K.; Koster, A. S. (Technische Hogeschool, Eindhoven, Netherlands). J. Phys., C (London); 8: No. 11, 1776-1782(7 Jun 1975).

X-ray L-fluorescence spectra of niobium metal and some of its compounds were studied with the help of a flat crystal, Philips semi-automatic x-ray spectrometer (PW 1220). The emission

spectra of niobium compounds are discussed with reference to the corresponding spectra of niobium metal. The change in intensity and shape of the $L\beta_2$ and $L\gamma_1$ emission bands is related to the involvement of the 4d electrons in the chemical bonding. (auth)

3513 MAGNETISM IN PRASEODYMIUM-NEODYMIUM SINGLE-CRYSTAL ALLOYS. Lebech, B.; McEwan, K. A.; Lindgaard, P. A. (Danish Atomic Energy Commission, Risoe). J. Phys., C (London); 8: No. 11, 1684-1696(7 Jun 1975).

Pr–Nd alloys represent an almost ideal model system for a mixture of singlet-doublet ions ($S_{eff} = 1$) and Kramers' doublet ions ($S_{eff} = \frac{1}{2}$). Whereas pure Pr has a singlet ground state and shows no ordering for T > 0.4°K, a small addition of Nd to Pr results in a relatively high ordering temperature, T_N, for the alloy. Neutron scattering and magnetization measurements were made on single crystals of Pr–3.0% Nd, Pr–5.5% Nd, and Pr–26.3% Nd. These alloys order antiferromagnetically (on the hexagonal sites) at 6.3, 6.5, and 11.4°K, respectively. In the Pr–26.3% Nd alloy, a ferromagnetic component was detected below 6–7°K at both the cubic and the hexagonal sites. Measurements of the magnetic-field dependence of the magnetization were also made. The concentration dependence of T_N and the temperature dependence and magnitude of the induced moments can be understood in terms of a simple molecular-field theory. It is concluded that pure Pr has a close-to-critical ratio between exchange interaction and the crystal field (≈0.95). The crystal field acting on the Nd ion is smaller than that acting on Pr. The exchange interactions between Pr–Pr, Nd–Nd, and Pr–Nd are found. The relative magnitudes agree with the de Gennes scaling factor. (auth)

3514 PRESSURE DEPENDENCE OF SUPERCONDUCTIVE TRANSITION TEMPERATURES IN ALLOYED COMPOUNDS $LaTl_{3-x}Pb_x$. Damsma, H.; Havinga, E. E. (Philips Gloeilampenfabrieken N. V., Eindhoven, Netherlands). Solid State Commun.; 17: No. 4, 409-411(15 Aug 1975).

The pressure dependence of T_c is reported for ten alloyed compounds $LaTl_{3-x}Pb_x$. The results are in the range $(\partial T_x/\partial p) = (-2.6 \pm 0.9) \times 10^{-5}$ k/bar. The room temperature compressibilities are found to be independent of x [$k = (18.1 \pm 0.6) \times 10^{-7}$ bar^{-1}]. (auth)

3515 NUCLEAR MAGNETIC RESONANCE OR ORIENTED ^{60}Co NUCLEI IN A DILUTE Co–Fe ALLOY. Kiesser, R.; Turrell, B. G. (British Columbia Univ., Vancouver, Canada). Solid State Commun.; 17: No. 4, 423-426(15 Aug 1975).

The technique of nuclear magnetic resonance on oriented nuclei has been used for the first time to study the distribution of hyperfine fields in an alloy. The sample investigated was a 1 at. % ^{59}Co–Fe alloy doped with ^{60}Co and data were obtained which compared favorably with conventional NMR results. (auth)

3516 HALL MOBILITY OF EXPANDED LIQUID CAESIUM IN THE METALLIC PROPAGATION RETION. Even, U.; Freyland, W. (Tel Aviv Univ., Israel). J. Phys., F (London); 5: No. 6, L104-L106(Jun 1975).

The Hall coefficient of expanded liquid cesium in the density range 1.9–1.1 g cm^{-3} exhibits a nearly free electron behavior, providing evidence for a relatively long mean free path even at reduced densities. (auth)

3517 SIZE EFFECTS, PEAKS IN CONCENTRATION FLUCTUATIONS AND LIQUIDUS CURVES OF Na–Cs. Bhatia, A. B.; March, N. H. (Alberta Univ., Edmonton, Canada). J. Phys., F (London); 5: No. 6, 1100-1106(Jun 1975).

Conformal solution theory applies to some binary alloys for which the volume differences are not too large. However, for Na–Cs, the volume ratio r = Cs/Na is 3 and this system is not conformal. A theory of the concentration fluctuations which is valid for large r is therefore described. By fixing the interchange energy, the single parameter in the theory, from the experimental activity data of Ichikawa et al (Ichikawa, K. and Thompson, J. C., 1974, J. Phys. F: Metal Phys. 4, L9, Ichikawa, K, Granstaff, S. M. and Thompson, J. C., 1974, J. Chem. Phys., 61, 4059), fairly good overall agreement with their results is obtained. The liquidus curves are then calculated from the same model. In agreement with observation, there is a rather flat portion of the liquidus around a Na concentration of 0.8 and this correlates directly with a strong peak in the concentration fluctuations around this composition. Na–Rb and a number of other alloy systems show a similar feature and these are briefly discussed. (auth)

3518 ELECTRONIC STRUCTURE OF Nb, NbC, AND NbN STUDIED BY X-RAY EMISSION. Kaelne, E. (Paris Univ., Orsay, France); Pessa, M. J. Phys., C (London); 8: No. 12, 1985-1990(21 Jun 1975).

New high-resolution x-ray fluorescence measurements of the NbL_3 emission band of Nb and NbN are presented. The NbL_1 emission of Nb, NbC, and NbN are compared with available density-of-states calculations. It is shown that only the NbC band can be described satisfactorily by an APW model. A complex satellite structure appears on the high-energy side of the parent Nb $L\alpha_{1,2}$ emission lines, and it is interpreted as due to L_3M–$M_{4,5}M$ double-vacancy distribution. No Nb $L\alpha_{1,2}$ line shift is observed in agreement with earlier results on NbC. (auth)

3519 LOW TEMPERATURE THERMAL EXPANSION OF PRASEODYMIUM BETWEEN 0.5 AND 25 K. Ott, H. R. (Eidgenoessisches Technische Hochschule, Zurich). Solid State Commun.; 16: No. 12, 1355-1358(15 Jun 1975).

The linear thermal expansion coefficients parallel and perpendicular to the hexagonal axis of single-crystal praseodymium were measured between 0.5 and 25°K and in external magnetic fields up to 12 kOe. $\alpha_{||} - \alpha_{\perp}$ is found to be of the order of 10^{-4} at 20°K, decreasing with decreasing temperatures. Below 1°K, evidence is found of a nuclear hyperfine contribution to the thermal expansion. A separation of the electronic term allows a determination of the electronic Gruenelsen parameter. (auth)

3520 ELECTRICAL RESISTANCE OF NIOBIUM-TITANIUM ALLOY AT HIGH TEMPERATURES. Logunov, A.V.; Petrushin, N.V. (Moscow). High Temp. 13: No. 1, 84-86 (Sept 1975).

Using an improved apparatus for measuring the thermophysical properties of metals and alloys at high temperatures, a study has been made of the specific resistance of a Nb-Ti alloy in the temperature range 1000–1900°C. The limit error of the measurements did not exceed 0.9%. The existence of a carbide phase in the alloy is demonstrated and the temperature of its complete solution has been determined. (auth)

3521 ELECTRICAL RESISTIVITY OF LANTHANUM, NEODYMIUM, AND ERBIUM AT HIGH TEMPERATURES. Mardykin, I.P. (A. A. Baikov Institute of Metallurgy, Academy of Sciences of the USSR). High Temp. 13: No. 1, 191-193 (Sept 1975).

The results of measurements of the specific electrical resistivity ρ of lanthanum, neodymium, and erbium are reported for the temperature range 800–1600°K, which includes the liquid-state region in the cases of lanthanum and neodymium. (auth)

3522 OPTICAL PROPERTIES OF TERBIUM IN THE VISIBLE AND INFRARED REGIONS OF THE SPECTRUM. Knyazev, Y.V.; Noskov, M.M. Opt. Spectrosc. (USSR) 38: No. 6, 672-675 (June 1975).

Polarimetric measurements of the index of refraction and absorption coefficient of polycrystalline terbium in the 0.289–20.0-μm wavelength region were carried out over the 80–450 K temperature range. An analysis of the optical properties, which determined the temperature dependency of the relaxation frequency of the conduction electrons, was carried out using experimental data from the ir frequency region. The observed peaks in the dispersion of the light conductivity $\sigma(\omega)$ are explained on the basis of the calculated electronic energy spectrum of metallic terbium. A resonance peak at ~0.50 eV was detected in the absorption spectrum on cooling the samples below the magnetic ordering point. (auth)

3523 NONLINEAR ABSORPTION OF SOUND IN GALLIUM IN THE SUPERCONDUCTING STATE. Fil', V.D.; Denisenko, V.I.; Bezuglyĭ, P.A. (Physico-technical Institute of Low Temperatures, Ukrainian Academy of Sciences). JETP Lett. 21: No. 12, 329-330 (20 June 1975).

Singularities in the behavior of absorption and velocity sound were observed in the region of the superconducting state near T_c under conditions when the sample was acted upon by an additional high-power ultrasonic field. These singularities seem to indicate a restructuring of the energy spectrum of the superconductor. (auth)

3524 INFLUENCE OF NICKEL PARAMAGNETIC IMPURITY ON THE SOFTENING OF LEAD DURING THE SUPERCONDUCTING TRANSITION. Abraimov, V.V.; Soldatov, V.P.; Startsev, V.I. (Physico-technical Institute of Low Temperatures, Ukrainian Academy of Sciences). JETP Lett. 21: No. 12, 334-335 (20 June 1975).

It is shown that introduction of a nickel paramagnetic impurity in lead leads to a considerable decrease of the softening of the metal during the superconducting transition. This may be due to the strong influence of the paramagnetic atoms on the spectrum of the electronic excitations in the superconductor. (auth)

3525 ELECTRON-STIMULATED DESORPTION OF OXYGEN ON A SINGLE-CRYSTAL SURFACE OF TUNGSTEN. Zingerman, Ya. P. (Inst. of Physics, Kiev). Sov. Phys.-Solid State; 16: No. 6, 1168-1169(Dec 1974).

Translated from Fiz. Tverd. Tela; 16: No. 6, 1795-1797(Jun 1974).

Results of the study show that the second layer of O atoms are located at the interstices of the surface lattice and that the electron-stimulated desorption from the first and second adsorption layers are essentially different. The electron-stimulated desorption of neutral atoms is the result of inelastic interaction of electrons with W surface atoms. (JRD)

3526 MAGNETOPLASTIC EFFECT IN DYSPROSIUM. Gindin, I. A.; Lavrinenko, I. S.; Neklyudov, I. M. (Physical-Technical Inst., Kharkov). Sov. Phys.-Solid State; 16: No. 6, 1084-1086(Dec 1974).

Translated from Fiz. Tverd. Tela; 16: No. 6, 1663-1667(Jun 1974).

Data relating to the magnetoplastic effect in nickel and dysprosium are presented: the yield stress falls when a magnetic field is applied as the samples are undergoing plastic deformation. This effect appears in dysprosium in the ferro-, and antiferro-, and paramagnetic states. The greatest effect occurs at low temperatures in the ferromagnetic state of dysprosium. An increase in the degree of deformation and the intensity of the alternating magnetic field increases the magnetoplastic effect. The deformation of dysprosium in a magnetic field is accompanied by a reduction in the tensile strength as well as the yield stress, and a rise in the relative elongation. These relationships are attributed to the interaction of moving dislocations with the boundaries of the magnetic domains. (auth)

3527 LITHIUM ADSORPTION ONTO THE FUNDAMENTAL FACES OF A TUNGSTEN SINGLE CRYSTAL. Medvedev, V. K.; Smereka, T. P. (Inst. of Physics, Kiev). Sov. Phys.-Solid State; 16: No. 6, 1046-1049(Dec 1974).

Translated from Fiz. Tverd. Tela; 16: No. 6, 1599-1605(Jun 1974).

The contact potential difference method was used to study lithium adsorption onto tungsten single-crystal (110), (112), (111), and (100) faces. The dependences of the work function φ, the adsorption heat q, and the Arrhenius equation preexponential factor ν on the lithium adatom concentration n were determined. It was shown that the lithium adsorption heat and work function experimental results for the various tungsten faces did not agree with the theory of Gyftopoulos and Steiner [Gyftopoulos et. al., 27 Annual Conf. Physical Electronics, MIT, Cambridge, 169(1967)]. and possible reasons for this are proposed. By comparing the φ(n) dependences with similar relationships obtained with a field emission microscope, it is shown that the latter is a particularly suitable instrument for quantitative adsorption studies. (auth)

3528 PHASE COMPOSITION AND MAGNETIC PROPERTIES OF FILMS OF COMPOUNDS OF RARE-EARTH METALS WITH METALS OF THE IRON GROUP. Buravikov, V. N.; Bochkarev, V. F.; Egorov, V. A.; Shelkovnikov, V. N. pp 254-256 of Redkozemzl'n. Med., Tsplavy i Soedineniya. Moscow; Izdatel'stvo Nauka (1973). (In Russian)

Studies were made of the phase composition and magnetic properties of films containing Sm, Gd, or Dy, and Fe, Ni, or Co, compounds with Th_2Ni_{17}-type structure being formed if the rare earth metal (REM) content in compounds with the d-metals is >15%. With increase in REM content in compounds of Gd or Sm with Ni, the relative magnetization falls sharply. In $GdFe_5$ and $DyCo_5$ alloys ($CoCu_5$ structure) the magnetic moments of the d- and f-metals compensate. The variation of the Hall emf and Hall const. R_1 with temperature during the annealing of $DyCo_5$ shows that for a single annealing process the Hall emf and R_1 change signs in the 310°C region. Shifts in the points of magnetic compensation that occur with repeated annealing of $DyCo_5$ (or $DyFe_5$) are attributed to phase transformations. The magnetic properties of $GdFe_5$ films were stable over a one-year period, and phase composition studies indicated that no oxidation of Ni-Gd, Co-Gd, or Fe-Gd films occurred in 1 to 3 year periods. (Metals Abstr.)

3529 EXPERIMENTAL STUDY ON THE MAGNETIC PROPERTIES OF Ni-Fe-Nb ALLOYS. Tai, L. C.; Hou, T. H. K'o Hsueh T'ung Pao; No. 3, 134-136(15 Mar 1975).

Results of a study are reported on nickel-iron-niobium alloys to meet the demand of new magnetic tapes and magnetic recording heads of high magnetic conductivity, attrition resistance, and hardness. The appropriate alloy composition (79.04% Ni, 7.75% Nb and 13.21% Fe), and the suitable processing and heat treatment conditions established are described. It was found that treatment at or above 1200°C can give also high hardness due to an extension of the lattice constant, and an elevation of the recrystallization temperature. (JPRS)

3530 STRUCTURAL EVOLUTION OF THE ALLOY FE-10 Ni-10 Mo BY TEMPERING AT A TEMPERATURE BELOW THE A_1 POINT. Knosp, B.; Lepine, G.; Cizeron, G. (Paris Univ., Orsay, France). Scr. Metall.; 9: No. 9, 901-906(Sep 1975). (In French)

The anomalous contraction observed in industrial steels of the maraging type was also observed in an Fe-10 Ni-10 Mo (wt. %) alloy. Differential thermal analysis was used to analyze the nature of the structural evolution causing this phenomenon. During heating at a rate of 300°/h, the following succession of events was observed in the original martensite structure: First there is a precipitation of the μ phase characterized by a small exothermic peak and a moderate increase of the hardness. In the temperature region between 550 and 650°C there is a contraction; the σ phase (FeMo) is precipitated which causes a significant increase of the hardness and is marked in the differential thermal analysis by a clearly exothermic peak. This contraction is primarily caused by the decrease of the parameter of the martensite matrix which rejects Mo from the solution to form the σ phase. (JSR)

3531 POSSIBLE EXPLANATION FOR THE ANOMALOUS SLIP OF BCC METALS FROM IN SITU EXPERIMENTS. Louchet, F.; Kubin, L. P. (CNRS, Toulouse). Scr. Metall.; 9: No. 9, 911-916(Sep 1975).

Distinctive features of the unexpected slip plane (0anti11) in the V group bcc metals (Nb, V, Ta) are listed. In-situ experiments in an electron microscope were used to observe dislocation motion in Nb single crystals under stress. A phenomenological two-dislocation model is proposed. (DLC)

3532 THERMODYNAMIC STUDY OF PHASE STABILITY IN THE THORIUM-COPPER EQUILIBRIUM SYSTEM. Bailey, D. M. Ames, IA; Iowa State Univ. (1975). 42p. University Microfilms Order No. 75-17,378.

Thesis (Ph. D.).

The thermodynamics of formation of the four intermediate phases in the thorium-copper equilibrium system were evaluated from electromotive force data obtained from solid state electrochemical cells with a calcium fluoride electrolyte. The free energies and enthalpies of formation are essentially constant, in units of kcal/g-atom Th, for the thorium-poor phases in this system, a feature shared with the Th-Fe, Th-Co, and Th-Ni systems. The trend in the magnitude of the enthalpy of formation of the thorium-poor phases in the Th-Fe, Th-Co, Th-Ni, and Th-Zn systems is in accord with the bonding energies for the d/sup n-2/ sp valence states for the respective transition metals (and for zinc): the value for the Th-Cu system is lower, corresponding more closely to the bonding energy of the monovalent $d^{10}s$ state for copper. (Diss. Abstr. Int., B)

3533 SINGLE CRYSTALLINE ELASTIC CONSTANTS OF Al_2Cu AND Zr_2Ni. Eshelman, F. R. Ames, IA; Iowa State Univ. (1975). 55p. University Microfilms Order No. 75-17,388.

Thesis (Ph. D.).

A pulse-echo-overlap system was used to measure the single crystalline elastic constants of the tetragonal Zr_2Ni and Al_2Cu phases in the temperature range 4.2 to 300°K. Mathematical relationships needed to calculate these elastic constants have been determined. The longitudinal elastic constants of Zr_2Ni, C_{11} and C_{33}, both exhibit a monotonic decrease with increasing temperature. The C_{66} shear constant of Zr_2Ni has a 72 percent monotonic increase with increasing temperature in the 4.2 to 300°K range and the other shear constants, C_{44} and 1/2 (C_{11}-C_{12}), are essentially temperature independent. The shear constants are noticeably smaller than the longitudinal constants, with C_{66} only 3.5 percent of C_{11} at 4.2°K. All the elastic constants of Al_2Cu exhibit a monotonic decrease with increasing temperature. The C_{44} volues of Al_2Cu show a 2 percent variation with direction that has been attributed to the presence of occluded particles of a second phase whose long dimension is oriented normal to the [001] direction. There is evidence that Al_2Cu forms peritectically which gives rise to the second phase particles. Arguments are given to show that the maximum error from the occluded second phase particles is about 2 percent. Zr_2Ni and Al_2Cu both have low longitudinal elastic anisotropy ratios and at least one high shear anisotropy ratio. In addition, one shear anisotropy ratio changes by 50 percent or more in the 4.2 to 300°K temperature range. The polycrystalline moduli for Zr_2Ni and Al_2Cu from Voigt-Reuss-Hill averaging are given. The low shear modulus for Zr_2Ni is in keeping with the low values of the shear elastic constants of single crystals of this phase. The Debye temperatures for these phases are given. (Diss. Abstr. Int., B)

3534 MULTIFILAMENTARY NIOBIUM TIN SUPERCONDUCTOR TAPE. Brisbin, P. H. (Intermagnetics General Corp., Guilderland, NY); Coles, W. D. (Intermagnetics General Corp., Guilderland, NY). IEEE (Inst. Electr. Electron. Eng.) Trans. Magn.; MAG-11: 283-286(1974).

In the method proposed for fabricating multifilamentary Nb_3Sn tape, filamentary superconducting paths are produced in standard commercial superconductor tape by chemical milling of separator slots through the Nb_3Sn layer. The multifilament configuration features a matrix of ten 1.2 mm wide parallel helical superconducting paths along the length of the tape. The paths are spaced 0.4 mm apart. Tapes tested as small pancake coils demonstrated the integrity and continuity of the matrix, and showed that critical current was sustained in direct proportion to retained superconductor. (IAA)

3535 ANALYTICAL CHEMICAL INVESTIGATION OF SULFIDE OF RARE EARTH ELEMENTS IN STEEL. Kawamura, K.; Watanabe, S.; Suzuki, T. (Nippon Steel Corp., Tokyo). Tetsu To Hagane; 60: No. 13, 1935-1943(Nov 1974). (In Japanese).

In order to establish a method for phase analysis of rare earth elements in hot rolled steels, the chemical behavior of various compounds of rare earth elements, both synthesized and extracted from the steels, was investigated. The extraction of compounds of rare earth elements from the steels was carried out well by electrolysis in non-aqueous medium, and the extracts were found by x-ray diffraction to contain sulfide, oxysulfide $(RE)_2O_2S$ and/or oxide of rare earth elements. The sample is electrolytically decomposed and the extracted residue is filtered. (Separation of combined rare earth elements). The amount of metallic rare earth elements is calculated by subtraction of combined rare earth elements fraction from the amount of total rare earth elements. The amount of rare earth sulfide fraction is calculated by subtraction of the amount of oxy-sulfide and oxide of rare earth elements fraction from the combined rare earth elements fractions. The method for phase analysis was applied to several hot rolled steels containing various amount of rare earth elements and sulfur. The result showed that the anisotropy (C/L) of impact values, the ratio of impact value normal to rolling direction and the one parallel to it under the same condition, is considerably affected by the yielding ratio (r) of rare earth sulfides. (auth)

3536 DEVICE AND METHOD OF MEASURING THERMOPHYSICAL PROPERTIES BY STEPWISE HEATING. Kumada, T. (Hokkaido Univ., Sapporo (Japan). Faculty of Engineering); Kobayashi, K. J. Nucl. Sci. Technol. (Tokyo); 12: No. 3, 154-160(Mar 1975).

A method for simultaneously measuring thermal diffusivity and specific heat has been developed from a previously proposed method, devised for measuring the thermal diffusivity of materials by means of samples in the form of small solid discs which are heated stepwise. The disc is placed in a vacuum furnace and heated on one surface by light, whose intensity is varied in steps. The resulting temperature rise reaching the other surface of the sample is recorded, from which the thermal diffusivity and the specific heat are both determined. The values obtained serve, in turn, to yield the thermal conductivity. An apparatus utilizing this principle has been devised, with which a nickel specimen was measured in the ranging from the room temperature to 1,300°K. (auth)

3537 TRANSIENT THERMAL STRESSES IN A CLAD MATERIAL WITH PARTIALLY HEATED SURFACE. Goshima, T.; Koizumi, T.; Nakahara, I. (Tokyo Inst. of Tech. (Japan)). Nippon Kikai Gakkai Rombunshu; 40: No. 338, 2755-2763(Oct 1974). (In Japanese).

It is very important to know the thermal stress of clad material for piston head and nuclear and chemical vessels used at high temperature and in corrosive environment, from the viewpoint of structural design and others. Transient thermal stress of the clad material consisting of a plate and a semi-infinite body was analyzed, when its surface was heated by the axis symmetric heat flux changing stepwise in course of time, with the aid of thermoelastic potential and stress function and by introducing Laplace transformation. The temperature distribution within the clad material was obtained by Laplace transformation and Hankel transformation. The perturbation method was adopted to satisfy boundary conditions. The obtained temperature distribution was introduced into the thermo-elasticity equations, and the final numerical results of thermal stress were obtained by adopting the model of 14Cr-stainless steel cladding attached to a semiinfinite body of low alloy steel under uniform heat flux. The thermal stress on the surface of the cladding was larger than that of the semi-infinite body of the same material as a thick plate, and the difference became larger as the radius of heating was larger and the duration of heating is longer. (JA)

3538 CONDUCTION MECHANISM AND T_C FOR GRANULAR TIN SAMPLES. Morozov, Yu. G.; Naumenko, I. G.; Petinov, V. I. (Inst. of Chemical Physics, Chernogolovka, USSR). Sov. Phys.-Solid State (Engl. Transl.); 16: No. 9, 1701-1703(Mar 1975).

Translated from Fiz. Tverd. Tela; 16: No. 9, 2621-2625(Sep 1974).

Effects of size and packing density of particles and effect of dielectric coating on the normal conductivity and T_c were studied for samples made by pressing together small particles of tin. It is shown that the normal conductivity of such samples depends on the particle size and is substantially lower than the conductivity of the metal. The temperature dependence of the sample resistance corresponds to the temperature dependence of the resistivity of alloys. The dielectric coating increases the normal conductivity, but its effect on T_c is small. A model is proposed for explaining the conductivity of the samples in the normal state. The T_c for the samples depends on the particle size and the packing density. The law for the change of the critical current as a function of the magnetic field corresponds to a filamentary structure in the samples. A possible mechanism for the increase of T_c in samples made by pressing small tin particles together is discussed. (auth)

3539 SUPERCONDUCTING PROPERTIES OF INDIUM AT HIGH PRESSURES. Il'ina, M. A.; Itskevich, E. S.; Titov, A. V. (Inst. of High-Pressure Physics, Moscow). Sov. Phys. – Solid State (Engl. Transl.); 16: No. 9, 1731-1732(Mar 1975).

Translated from Fiz. Tverd. Tela; 16: No. 9, 2674-2677(Sep 1974).

Effect of quasihydrostatic pressures up to ≈60 kbar on T_c and H_c of indium was investigated. A change in the values of dT_c/dP and $(dH_c/dP)_{T=const}$ was found in the pressure range 32 to 40 kbar. This behavior is attributed to a charge in the Fermi-surface topology of indium. (auth)

3540 TRANSPORT PROPERTIES OF SAMARIUM AT HIGH TEMPERATURES. Zinov'ev, V. E.; Gel'd, P. V.; Sokolov, A. L. (Ural Polytechnic Inst., Sverdlovsk, USSR). Sov. Phys. – Solid State (Engl. Transl.); 16: No. 9, 1776(Mar 1975).

Translated from Fiz. Tverd. Tela; 16: No. 9, 2745-2746(Sep 1974).

Temperature dependences were studied of the thermal diffusivity between 550 and 1080°K and the electric resistivity between 290 and 1000°K. A phase transition at 690°K was found. (DLC)

3541 EFFECT OF PRESSURE ON IMPURITY CONDUCTION OF N-TYPE InSb. Itskevich, E. S.; Kashirskaya, L. M. (Inst. of High-Pressure Physics, Moscow). Sov. Phys. – Solid State (Engl. Transl.); 16: No. 10, 1888-1892(Apr 1975).

Translated from Fiz. Tverd. Tela; 16: No. 10, 2917-2924(Oct 1974).

The Hall effect, longitudinal and transverse magnetoresistivity at liquid-helium temperature in magnetic fields up to 50 kOe, and temperature dependence of the electrical resistivity from 300 to 1.4°K were determined for n-type InSb samples with exhaustion carrier densities $n_0 = 10^{13}-10^{15}$ cm^{-3} at pressures up to 14 kbar. The experimental results at the lowest temperatures are interpreted in terms of impurity conduction by a hopping mechanism, and a satisfactory agreement with the Shklovskii theory is found. The activation energy E_3 for hopping conduction is independent of magnetic field and pressure. The pressure dependence of the measured quantities confirms that in the range 5-7 kbar at T = 4.2°K there are effects due to deep levels which were previously found at T = 77°K by a number of authors. (auth)

3542 MAGNETIC FREEZE-OUT IN N-TYPE InSb UNDER PRESSURE. Itskevich, E. S.; Kashirskaya, L. M.; Sukhoparov, V. A. (Inst. of High-Pressure Physics, Moscow). Sov. Phys. - Solid State (Engl. Transl.); 16: No. 10, 1893-1898(Apr 1975)..

Translated from Fiz. Tverd. Tela; 16: No. 10, 2925-2933(Oct 1974).

The Hall effect, longitudinal and transverse magnetoresistivity at liquid-helium temperature in magnetic fields up to 50 kOe, and electric-field dependences (in the range 0.001-1 V/cm) of the electrical resistivity and weak-field Hall coefficient were determined for n-type InSb samples with exhaustion carrier densities $n_0 = 10^{13}-10^{15}$ cm^{-3} at pressures up to 13 kbar. The pressure dependence of the ionization energy of impurity electrons in a magnetic field were calculated at various pressures. The magnetic part of this ionization energy is independent of pressure. (auth)

3543 MAGNETIC PROPERTIES OF GRANULAR SUPERCONDUCTORS MADE WITH SMALL TIN PARTICLES. Morozov, Yu. G.; Naumenko, I. G.; Petinov, V. I. (Inst. of Chemical Physics, Chernogolovka, USSR). Sov. Phys. – Solid State (Engl. Transl.); 16: No. 10, 1974-1976(Apr 1975).

Translated from Fiz. Tverd. Tela; 16: No. 10, 3057-3061(Oct 1974).

The magnetic properties of granular tin samples made by pressing small particles together were studied. The particle size d was varied from 2100 to 200 Å. The magnetization curves of granular tin correspond to a "hard" superconductor. The peculiarities of granular tin are: the absence of a Meissner effect (when the samples are cooled below T_c the magnetic flux is not expelled from them), a large difference between the temperatures for the transition into the normal state found from the M(H) and R(H) relations, and the presence of superconducting regions in the temperature range where the sample resistance corresponds to the normal resistance. Near T_c the relation $H_{c2}(T)$ was measured for granular tin with various sizes d. A comparison is made between the electron mean free paths in granular tin found from magnetic measurements and the absolute values of the conductivity and the dependence R(T). An explanation of the magnetic properties of granular tin is given assuming a filamentary structure for granular tin. (auth)

3544 ULTRASONIC GENERATION IN P-TYPE InSb. Bykovskii, Yu. A.; Protasov, E. A.; Toloknov, N. A. (Moscow Engineering Physics Inst.). Sov. Phys.–Solid State (Engl. Transl.); 16: No. 10, 1979-1980(Apr 1975).

Translated from Fiz. Tverd. Tela; 16: No. 10, 3065-3067(Oct 1974).

Ultrasonic generation was detected experimentally at 4.2°K in p-type InSb at frequencies corresponding to the resonant frequencies of the resonator formed by the plane-parallel ends of the samples. Under conditions such that the hole velocity is higher than the ultrasonic velocity in InSb, the ultrasound is accompanied by current and voltage oscillations. The generation spectra of the spontaneous noise oscillations and the induced oscillations were studied. A study was also made of how the generation was affected by a misalignment of the ends of the samples. (auth)

3545 HYPERFINE FIELDS IN $GdFe_3$ AND YFe_3 INTERMETALLIC COMPOUNDS. Nikitin, S. A.; Vasil'kovskii, V. A.; Kovtun, N. M.; Kupriyanov, A. K.; Ostrovskii, V. F. (Moscow State Univ.). Sov. Phys.–Solid State (Engl. Transl.); 16: No. 10, 2031-2032(Apr 1975).

Translated from Fiz. Tverd. Tela; 16: No. 10, 3137-3139(Oct 1974).

Hyperfine fields at the ^{155}Gd, ^{157}Gd, ^{89}Y, and ^{57}Fe nuclei were determined by the spin echo method at 4.2°K. Seven NMR lines were observed for $GdFe_3$ and three for YFe_3; their resonance frequencies and hyperfine fields were determined. The magnetic moments of Fe in $GdFe_3$ were calculated. The Fe moment is proportional to the hyperfine field at the Fe nuclei, indicating strong localization of the d electrons near the Fe ions. (DLC)

3546 *INFLUENCE OF HYDROSTATIC PRESSURES UP TO 17 KBAR ON THE ELASTIC MODULI OF InSb.* Bashkin, I. O.; Peresada, G. I. (Inst. of Solid-State Physics, Chernogolovka, USSR). Sov. Phys.–Solid State (Engl. Transl.); 16: No. 10, 2058 (Apr 1975).

Translated from Fiz. Tverd. Tela; 16: No. 10, 3166-3167(Oct 1974).

The constants C_{11}, C_{12}, C_{44}, B_t, and B_v were measured for a single crystal of n-type InSb. Results were analyzed by the least-squares method and their pressure and temperature derivatives calculated. (DLC)

3547 MOBILITY OF SCREW DISLOCATIONS IN InSb CRYSTALS. Erofeeva, S. A.; Osip'yan, Yu. A. (Inst. of Solid-State Physics, Chernogolovka, USSR). Sov. Phys.–Solid State (Engl. Transl.); 16: No. 10, 2076-2077(Apr 1975).

Translated from Fiz. Tverd. Tela; 16: No. 10, 3185-3186(Oct 1974).

Layer-by-layer chemical etching and the Lang x-ray transmission method were used to study the structure of dislocations appearing in InSb crystals during the initial stage of plastic deformation. Two types of dislocation half-loops with different directions of Burgers vector were observed; they were used to measure the velocity of screw dislocations at 100 to 300°C under shear stresses of 0.5, 1.5, and 3 kg/mm^2, with various dopants (none, Te, Zn). Results indicate that the mobility depends not only on external conditions (T, stress) and defect concentration, but also on the structure of the dislocations themselves. (DLC)

3548 X-RAY STUDY OF THE SYSTEMS IRIDIUM–LANTHANUM AND IRIDIUM–CERIUM. Vorob'ev, V. D.; Mel'nikova, V. A. Sov. Phys.–Crystallogr. (Engl. Transl.); 19: No. 3, 397-399(1974).

Translated from Kristallografiya; 19: No. 3, 642-644(1974).

Unit cell parameters were determined for $LaIr_3$, La_2Ir_7, $LaIr_5$, $CeIr_3$, and $CeIr_5$. Phase compositions, interplanar distances, indices, and relative intensities are also given. Two other compounds were found: LaIr and La_3Ir_{17}. (DLC)

3549 REVIEW OF CHROMIUM, MOLYBDENUM, AND TUNGSTEN ALLOYS. Klogg, W. D. (Lewis Research Center, Cleveland). J. Less-Common Met.; 42: No. 3, 261-278(Oct 1975).

The mechanical properties of chromium, molybdenum, and tungsten alloys are reviewed, with particular emphasis on high-temperature strength and low-temperature ductility. Precipitate strengthening is highly effective at $0.4-0.8T_m$ in these metals, with HfC being most effective in tungsten and molybdenum, and Ta(B,C) most effective in chromium. Low-temperature ductility can be improved by alloying to promote rhenium ductilizing or solution softening. The low-temperature mechanical properties of these alloys appear related to electronic interactions rather than to the usual metallurgical considerations. (auth)

3550 TERNARY PHASES OF THE TYPE $M^{IV}V_2M^{IB(IIB)}Hg_2$. Puselj, M.; Ban, Z. (Univ., Zagreb). J. Less-Common Met.; 42: No. 3, 279-283(Oct 1975). (In German)

During the investigation of the ternary systems Tl–Ag–Hg and Tl–Cd–Hg, two new ternary phases were detected and characterized using x-ray powder diffraction techniques. The compositions of the phases are $TlCdHg_2$ and $TlAgHg_2$, respectively. Both are tetragonal and belong to the AuCu structure type. In addition, all the phases of general composition $M^{IV}VM^{IB(IIB)}Hg_2$ described and their structural features discussed. (auth)

3551 LOW-TEMPERATURE-CALORIMETRIC STUDIES OF SUPERCONDUCTIVITY AND MICROSTRUCTURE IN TITANIUM–VANADIUM ALLOYS. Collings, E. W. (Battelle Columbus Labs., Ohio); Upton, P. E.; Ho, J. C. J. Less-Common Met.; 42: No. 3, 285-301(Oct 1975).

The results of a low-temperature, specific-heat investigation of a sequence of Ti–V(3–90 at.%) alloys are reported. The electronic specific heat coefficient, γ, and superconducting transition temperature, T_c, respond strongly to the composition- and heat-treatment-dependent microstructural states of the alloys. In particular, the presence of ω-phase precipitation is responsible for pronounced depressions of γ and T_c in the composition range of about 13 through 25 at.% V. As density-of-states-related quantities, γ, T_c, and χ(the magnetic susceptibility, discussed in an earlier paper) all follow similar trends when measured in the as-quenched alloys. ω-Phase, when it occurs in such alloys, reduces the measured γ and χ values by weighted averaging, and reduces T_c through the operation of a complete proximity effect. On the other hand, during the aging of a pair of selected members of the series under investigation (viz., Ti–V(15 at.%) and Ti–V(19 at.%)), although γ and χ continue to decrease as ω-phase develops, T_c increases and the superconducting transition broadens. The aging situation is analyzed in terms of an incomplete proximity effect which evolves as the ω-phase precipitates increase in size with aging time. (auth)

3552 SYNTHESIS AND ELECTRICAL BEHAVIOR OF SOME COMPOUNDS OF THE Mn_5Si_3 TYPE STRUCTURE. Niculescu, D.; Bradea, I.; Ivanciu, O.; Cruceanu, E. (Inst. of Physics, Bucharest). J. Less-Common Met.; 42: No. 3, 311-314(Oct 1975).

Three compounds with an Mn_5Si_3-type crystal structure have been studied; of these, Y_5Sn_3 and Y_5Pb_3 were found to be unstable in air, but Y_5Si_3 was stable. This difference is attributed to the stronger covalent component of the chemical bond in Y_5Si_3. Electrical measurements on this material have been carried out and a characteristic temperature of 225°K has been obtained. (auth)

3553 SOLUBILITIES, AND SOLUTION AND SOLVATION ENTHALPIES, FOR NITROGEN AND HYDROGEN IN LIQUID LITHIUM. Adams, P. F.; Down, M. G.; Hubberstey, P.; Pulham, R. J. (Univ. of Nottingham, Eng.). J. Less-Common Met.; 42: No. 3, 325-334(Oct 1975).

The solubilities of nitrogen and of hydrogen in liquid lithium have been determined up to 2.77 mol% N and 5.68 mol% H by electrical resistance methods, and they can be represented, in part, by the equations $\log_{10}x_N = 1.168 - (2036/T)$, $473 < T < 708$°K and $\log_{10}x_H = 1.523 - (2308/T)$, $523 < T < 775$°K where x is the solute mole fraction. The results show that the nitrogen and hydrogen content of lithium can be reduced to 0.08 and 0.03 mol%, respectively, by filtration at 200°C. Solubilities provide values of the partial molar enthalpies, $H_{(soln)}$, and entropies, $S_{(soln)}$ (with respect to the precipitating phase), of solution of 39.23 kJ mol^{-1} and 22.35 J K^{-1} mol^{-1} (for Li_3N), and 44.18 kJ mol^{-1} and 29.15 J K^{-1} mol^{-1} (for LiH). The values of $H_{(soln)}$ are used to derive solvation enthalpies of –3473 and –427 kJ mol^{-1} for nitride and hydride ions, respectively, in the metal. The hydrogen solubilities augment the liquids of the Li–LiH phase diagram. (auth)

3554 POWDER METALLURGICAL SYNTHESIS OF THE SUPERCONDUCTING NIOBIUM–ALUMINIUM–GERMANIUM A15 PHASE. Cave, J. A. (De Beers Diamond Research Centre, Johannesburg); Davies, T. J.; Carpenter, F. C. J. Less-Common Met.; 42: No. 3, 335-344(Oct 1975).

A preliminary study has been carried out in which the A15 phase of the Nb–Al–Ge system was synthesised by sintering compacts of mixed elemental powders at 1673, 1873 and 2073°K, for periods of up to 120 min. Onset superconducting transition temperatures of ≤19.9°K were obtained which were increased to ≤18.9°K by a secondary heat treatment at 1073°K. Metallographic observations and results from electron microprobe analysis are reported, and the mechanism of A15 phase formation is discussed. Some consideration is given to the future development of the technique. (auth)

3555 PREPARATION AND X-RAY DIFFRACTION STUDY OF $PaBe_{13}$, $AmBe_{13}$, AND $CmBe_{13}$. Benedict, U.; Buijs, K.; Dufour, C.; Toussaint, J. C. (European Inst. for Transuranium Elements, Karlsruhe, Ger.). J. Less-Common Met.; 42: No. 3, 345-354 (Oct 1975).

$PaBe_{13}$, $AmBe_{13}$ and $CmBe_{13}$ were prepared by beryllothermic reduction of the corresponding oxides. Start and completion of the reaction were monitored by a neutron rem-counter. The compounds are of the $NaZn_{13}$ structure-type with a = 10.26 ($PaBe_{13}$), a = 10.29 ($AmBe_{13}$), and a = 10.27 ($CmBe_{13}$). Increase of the lattice parameter of $CmBe_{13}$ by self-irradiation damage is much slower than with curium oxides. The lattice parameters of beryllium-rich and actinide-rich $AmBe_{13}$ compounds are compared with the lattice parameter curve of 1:13 lanthanide beryllides. A review of the distribution of known $NaZn_{13}$-type compounds throughout the Periodic Table and on their relative x-ray diffraction line intensities has been made. (auth)

3556 SUPERCONDUCTIVITY OF NEW METASTABLE PHASES OF NIOBIUM–IRIDIUM, TANTALUM–IRIDIUM, AND TANTALUM–RHODIUM. Johnson, W. L.; Poon, S. J. (California Inst. of Tech., Pasadena). J. Less-Common Met.; 42: No. 3, 355-358(Oct 1975).

The alloys were prepared by induction-melting of the constituents on a silver boat under an argon atmosphere. The ternary alloys were prepared by the addition of Nb_2O_5 or carbon powder to the melt. Each ingot was remelted several times. Weight loss during the preparation process was less than 0.1% for all the alloys. Subsequent annealing was carried out in evacuated quartz tubes. The crystal structures of all the phases were obtained from the Debye–Sherrer films. The superconducting transitions were observed using a standard inductance bridge technique. Data and information on transition temperatures and phases are presented and discussed. (JRD)

3557 ELECTRICAL RESISTIVITY OF UGa AND UGa_2. Smetana, Z. (Charles Univ., Prague); Houdek, V.; Menovsky, A.; Simsa, Z. Phys. Status Solidi (a); 28: No. 2, K103-K105(16 Apr 1975).

The temperature dependence of the electrical resistivity of UGa and UGa_2 was studied from 4.2 to 300°K, which covered their Neel and Curie transitions, respectively. The resistivity of UGa_2 shows a kink at the Curie temperature of 127°K; that of UGa has its kink at $T_N \sim 27$°K. Results are in good agreement with the localized spin fluctuations model. (DLC)

3558 MAGNETIC PROPERTIES OF UPd_4. Murasik, A. (Inst. of Nuclear Research, Warsaw); Leciejewicz, J.; Zygmunt, A. Phys. Status Solidi (a); 28: No. 2, K107-K110(16 Apr 1975).

Susceptibility measurements were performed on UPd_4 at 4.2 to 300°K, and a neutron diffraction study was carried out at 4.2, 83, and 293°K. χ_g^{-1} is linear with T from 300 to 30°K, yielding a Weiss constant of –130°K and an effective moment of 3.47 μ_B. Below 30°K, a deviation from the Curie–Weiss law and a shallow min at 10°K occurs; results indicate antiferromagnetic ordering. The magnetic unit cell is formed by doubling the chemical one in two directions. The magnetic structure factor is $\bar{F}_M(hkl) = q_{hkl}$ $p[1-\cos\pi h-\cos\pi k+\cos\pi(h+k)]$. Ordered moments per U atom were determined to be 0.8μ_B. The moments are aligned perpendicularly to the 001 axis. (DLC)

3559 MAGNETIC INVESTIGATIONS ON $Dy(Fe_xAl_{1-x})_2$ LAVES PHASE COMPOUNDS. Groessinger, R.; Steiner, W. (Technische Hochschule, Vienna). Phys. Status Solidi (a); 28: No. 2, K135-K138(16 Apr 1975).

Two structure types are formed: cubic $MgCu_2$ type for $1 \geq x \geq 0.67$ and $0.4 \geq x \geq 0$, and hexagonal $MgZn_2$ type for $0.57 \geq x \geq 0.47$. The Curie points increase linearly with x up to x = 0.67. The field dependence of the 4.2°K magnetization and the x influence on remanence and He were measured. Saturation moments were also determined. Results show that the Fe moment decreases with decreasing x up to x = 0.67 as if Al acts as a simple dilution. Similar results were obtained for $Ho(Fe,Al)_2$ and $Gd(Fe,Al)_2$. (DLC)

3560 THERMOMAGNETIC PROPERTIES OF InSb–In FILMS. Kaila, M. M.; Goldsmid, H. J. (Univ. of New South Wales, Kensington). Phys. Status Solidi (a); 28: No. 2, K167-K170(16 Apr 1975).

Experiments were carried out at 300°K on the Nernst and magneto-Seebeck effects. These properties are shown to be useful in formulating a model for two-phase semiconductor-metal materials. In this model, there are metallic filaments which contribute a fraction K_x to be zero-field conductivity in the x direction and K_y in the y direction. (DLC)

3561 EFFECTS OF HYDROGEN AND OXYGEN ON THE ELASTIC MODULI OF VANADIUM, NIOBIUM, AND TANTALUM SINGLE CRYSTALS. Fisher, E. S.; Westlake, D. G.; Ockers, S. T. (Argonne National Lab., IL). Phys. Status Solidi (a); 28: No. 2, 591-602(16 Apr 1975).

Measurements of the ultrasonic wave velocities at 30 to 50 MHz frequencies reveal very significant effects of dissolved hydrogen on the elastic shear moduli, C' equals $(C_{11}-C_{12})/2$ and C_{44}, of the group V bcc transition metals. In all cases, C' decreases with increasing hydrogen solute, whereas C_{44} increases and the bulk modulus remains nearly constant. The DELTA C' effect is interpreted as a Snoek relaxation that arises from a tetragonal elastic dipole produced by interstitial hydrogen in tetrahedral sites. The data indicate that the tetragonal distortion parameter, $lambda_1 - lambda_3$, is 0.11 for V, 0.051 for Nb, and 0.047 for Ta. The rate of increase in C_{44} is 0.5 percent per at. percent hydrogen for V, 1.8 percent for Nb, and 0.13 percent for Ta. This increase is reflected in a positive change in the isotropic Young's modulus for Nb, opposing the Snoek relaxation effect. The addition of oxygen to V and Nb produces no Snoek relaxation at these high frequencies, but the positive change in C_{44} is as pronounced as in the hydrogen addition. Present information is not sufficient to relate this DELTA C_{44} effect strictly to the interstitial solute configuration. (auth)

3562 SPECTROSCOPY OF INTERCONFIGURATIONAL FLUCTUATIONS IN RARE EARTH COMPOUNDS. Campagna, M. (Bell Labs., Murray Hill, NJ); Wertheim, G. K.; Bucher, E. AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 22-26(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

After a brief discussion on the application of x-ray photoemission (XPS) to the study of multiplet structures and intensities in 4f-photoemission, XPS spectra of 4f-electrons in rare earth compounds with intermediate valence state are presented. This technique provides an instantaneous picture of the electronic configuration, and in each case shows the presence of both divalent and trivalent ions, which are identified by their multiplet structure and chemical shifts. These results allow a direct estimate of the Coulomb correlation energy U/sub eff/ within 4f-shells and demonstrate that Hund's rule correlation is well preserved within a "nonmagnetic," delocalized 4f-shell. Recent temperature dependent XPS-studies are reviewed for two distinct systems, the Tm monochalcogenides and the "chemically collapsed" (golden) phases of SmS. Their relation to other physical properties, especially lattice constant, is analyzed. Implications of these observations for the understanding of the semiconductor-to-metal transition in these compounds and the related peculiar magnetic properties are discussed. (auth)

3563 EXCITED-STATE SPIN WAVES, SOFT MODES, AND CRYSTAL FIELD EFFECTS. Buyers, W. J. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 27-32(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

There are several branches of the spin-wave spectrum in materials where the exchange and crystalline field are comparable. Spin waves out of excited states can play an important role by mixing and interacting with the conventional spin waves out of the ground state. These effects are illustrated by neutron scattering results for TbSb, where several branches were observed, for $TbAl_2$, where an excited-state spin wave has been directly observed, and for Pr_3Tl where the mode-mode interaction has been found to be responsible in part for the surprising lack of temperature dependence through T/sub c/ of the spin-wave peak. A theory of the dynamical susceptibility has been developed that includes, in RPA, all spin waves allowed within the ground multiplet, and is found to be in good agreement with experiment in contrast to the singlet-singlet or singlet-triplet models. For Pr_3Tl, as T yields T/sub c/ the frequencies of the singlet-triplet modes decrease but remain finite. The modes within the triplets do tend to zero frequency at T/sub c/, but do not drive the transition since they are entirely transverse. The soft "mode" is a zero-frequency mode that appears in the scattering as a central peak that diverges at the phase transition. The central peak, which arises from localized spin fluctuations, has probably been observed in TbSb. (8 figures) (auth)

3564 MAGNETISM IN RARE EARTH-TRANSITION METAL AMORPHOUS ALLOY FILMS. Lee, K.; Heiman, N. (IBM Research Lab., San Jose, CA). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 108-109(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

A number of rare earth (RE) transition metal (TM) amorphous alloy films (RE equals Gd, Ho, Tb, Y; TM equals Co, Fe, Ni, Mn) were prepared across a broad compositional range by thermal evaporation and examined by polar Faraday rotation, polar Kerr rotation, and magnetometer techniques. Results show that the major differences between amorphous and crystalline alloys are due to the altered state of the TM. Specifically the ordering tem-

perature of amorphous RE–Ni and RE–Co alloys is higher than in the corresponding crystalline alloys, whereas the reverse is true for RE–Fe alloys; at the same time, the TM "sublattice" magnetization is larger in the amorphous state for both Fe and Co compounds. Furthermore amorphous RE–Mn alloys are not ordered. These facts tend to support the general concepts of the charge transfer model. Other properties such as coercivity and anisotropy are strongly dependent on the RE constituent. (auth)

3565 TEMPERATURE DEPENDENCE OF MAGNETIZATION IN AMORPHOUS Gd–Co–Mo FILMS. Hasegawa, R.; Argyle, B. E.; Tao, L. J. (IBM Research Center, Yorktown Heights, NY). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 110-112(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

The temperature dependence of the magnetization of amorphous ferrimagnetic (Gd/sub 1-x/Co/sub x/)/sub 1-y/Mo/sub y/ films prepared by rf sputtering with x equals 0.79–0.88 and y equals 0,08–0,16 was studied in the temperature range 4,2–500°K. The data, taken using a vibrating sample magnetometer and the polar Kerr effect, were found to be satisfactorily described by Neel's two sublattice model. (auth)

3566 GALVANOMAGNETIC EFFECTS IN Gd–Co SPUTTERED FILMS. Okamoto, K.; Shirakawa, T.; Matsushita, S.; Sakurai, Y. (Univ. of Osaka). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 113-114(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

The transverse Hall effect (THE) and the transverse magnetoresistance effect (TME) are measured simultaneously in Gd–Co sputtered films which have the uniaxial magnetic anisotropy perpendicular to the film plane. Results show that the THE loop is related to the magnetization curve, and that the Hall output voltage, V/sub H/, is proportional to the total area of reversed magnetic domains in the sample. It is also found that the fractional change of resistance, DELTA R/R, depends on the number of magnetic domain walls with which the control current interacts. The magnitude of DELTA R/R is of the order of 10^{-4} or less. (auth)

3567 MAGNETIC HYPERFINE STRUCTURE IN AMORPHOUS $DyFe_2$. Forester, D. W. (Naval Research Lab., Washington, DC); Abbundi, R.; Segnan, R.; Sweger, D. AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 115-116(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Results are summarized of a Moessbauer study of the amorphous rare earth–transition metal alloy $DyFe_2$ in the magnetically ordered state. Both the ^{57}Fe and ^{161}Dy spectra were investigated as a function of temperature and reveal a broad, though measurable, distribution of Fe hyperfine fields (H/sub eff/) and quadrupole splittings (QS). There is a distribution similar in magnitude for the Dy hyperfine fields but the observed quadrupole splittings are narrowly distributed. The temperature variation of the ^{161}Dy spectra indicates a large variation of local exchange splittings at the Dy sites. These results are discussed in terms of a model in which the Dy spins are more strongly coupled to their random-direction anisotropy axes than to the neighboring Fe spins (which also experience a weaker random-direction anisotropy.) (auth)

3568 "CRITICAL" NEUTRON SCATTERING IN AMORPHOUS $HoFe_2$ AND $GdFe_2$. Pickart, S. J. (Naval Ordnance Lab., White Oak, MD); Rhyne, J. J.; Alperin, H. A. AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 117-118(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Small-angle neutron scattering measurements were made on amorphous $HoFe_2$ and $GdFe_2$. For $HoFe_2$, the intensity for T greater than or equal to T/sub c/ (195°K) is Lorentzian in form and can be analyzed for an inverse correlation length $kappa_1$ which remains finite at T/sub c/. Below T/sub c/, a giant anomalous magnetic component appears, which follows a $q^{-2.4}$ dependence and can be analyzed in terms of magnetic inhomogeneities of dimension comparable to $kappa^{-1}$/sub perpendicular to/ at T/sub c/. Limited measurements at fixed q indicate the absence of this component in $GdFe_2$, suggesting an origin based on local crystalline field effects. (auth)

3569 INELASTIC MAGNETIC SCATTERING FROM AMORPHOUS $TbFe_2$. Rhyne, J. J. (Naval Ordnance Lab., White Oak, MD); Price, D. L.; Mook, H. A. AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 121-122(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Inelastic neutron scattering measurements were made on sputter-deposited amorphous Tb/sub Q33/Fe/sub Q67/ using time-of-flight spectrometers. At 433°K (above T/sub c/), the magnetic scattering function S(Q,omega) exhibited an approximate Gaussian dependence on energy transfer characteristic of a paramagnet. Below T/sub c/, at 299°K, a broad distribution of magnetic inelastic scattering is present centered approximately at DELTA E equals 11 MeV. As expected this distribution was significantly broadened and was shifted to a lower energy than the equivalent polycrystalline compound $TbFe_2$ which showed a single inelastic peak near 18 MeV. Polarized beam time-of-flight data showed evidence for discrete spin wave excitations for Q less than or equal to 1,0 A^{-1} in the amorphous sample. (auth)

3570 MAGNETIC EXCITATIONS IN RARE EARTH Al_2 COMPOUNDS. Bak, P. (Atomic Energy Commission Research Establishment, Risoe, Denmark). AIP (Am. Inst. Phys.) Conf. Proc., No. 24, 152-158(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Excitons in $NdAl_2$ and $TbAl_2$ were studied by inelastic neutron scattering. The dispersion relations are analysed within the random phase approximation using a Hamiltonian including 4th and 6th order crystal field terms and an isotropic exchange interaction. The spectrum of $NdAl_2$ at 5°K comprises both transverse and longitudinal modes, corresponding to transitions between the ground state and excited mean-field states. The bulk magnetic properties of $NdAl_2$ can be understood quantitatively using the crystal field parameters derived from the analysis of the exciton spectrum. At 4°K the magnetic excitations in $TbAl_2$ are spin waves. At temperatures above 35°K the neutron scattering measurements show a double peak structure. This splitting of the spin wave branch is the result of an interaction between the spin waves and excitations associated with higher-lying mean-field states, a magnon–exciton interaction. (auth)

3571 MULTIPLET SPLITTING OF X-RAY PHOTOEMISSION SPECTRA CORE LEVELS IN MAGNETIC METALS. Kowalczyk, S. P.; McFeely, F. R.; Ley, L.; Shirley, D. A. (Univ. of California, Berkeley). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 207-208(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Results of high-resolution x-ray photoemission studies of the multiplet splitting of the 3s core levels in the 3d transition metals and the 4s, 5s, and 4d core levels in the lanthanide metals are reported. (auth)

3572 TEMPERATURE INDEPENDENT ^{55}Mn MAGNETIC HYPERFINE FIELDS IN $ErMn_2$ AND $TmMn_2$. Barnes, R. G.; Lunde, B. K. (Ames Lab., IA). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 217-218(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Analysis of the complex NMR spectra of ^{55}Mn in the hexagonal Laves phase compounds $ErMn_2$ and $TmMn_2$ reveals only a very slight temperature dependence of the ^{55}Mn Knight shift K at either of the two inequivalent lattice sites, in contrast to the Curie–Weiss behavior of the susceptibility of these compounds and their known ferromagnetic ordering properties. In addition, K differs negligibly from that in isostructural $ScMn_2$ which does not order magnetically. Both neutron diffraction and NMR data indicate that Mn carries no local moment, and the Knight shift measurements suggest that K results essentially entirely from the orbital contribution, K/sub orb/. Unlike the case of the $LnAl_2$ cubic Laves phase compounds, for example, the net contribution to K resulting from indirect interaction between ^{55}Mn and the rare-earth moments is relatively small. (auth)

3573 CALORIMETRIC EVIDENCE FOR SPIN FLUCTUATIONS IN UAl_2. Trainor, R. J. (Argonne National Lab., IL); Brodsky, M. B.; Isaacs, L. L. AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 220-222(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Results are presented of heat capacity measurements on UAl_2 between 1.8 and 400°K. The data are compared with recent resistivity and susceptibility measurements which indicate the existence of localized spin fluctuations in a narrow 5f band. Below about 50°K, the electronic contribution to the heat capacity becomes

large, equivalent to gamma approximately 70 mJ/mole-K^2. Below 6K, there is an upturn in C/T which is proportional to T^2 log (T/T/sub SF/), where T/sub SF/ equals 10.6°K is identified as the spin fluctuation temperature. Extrapolation of this term to zero temperature yields m*/m approximately 2 for the spin-fluctuation mass enhancement. At 300°K, UAl_2 exhibits more typical metallic behavior, with gamma approximately 15 mJ/mole-K^2. Data are also presented for nonmagnetic URh_3; at low temperatures C equals gamma T + beta T^3, with gamma equals 14.5 mJ/mole-K^2 and beta corresponding to theta/sub D/ equals 336°K. (auth)

3574 ROLE OF ITINERANT 5f STATES ON THE FERMI SURFACE OF Th AND POSSIBLE IMPURITY LOCAL MOMENT FORMATION. Koelling, D. D. (Argonne National Lab., IL); Freeman, A. J. AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 223-224(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

The nature (itinerant vs. localized) of the 5f electrons in the actinides determines their magnetic properties. Extensive optical and de Haas–van Alphen data which exist only for Th, the simplest actinide with no occupied 5f states, allow detailed comparisons to be made between theory and experiment. The 5f bands were found, by means of ab initio RAPW energy band calculations, to lie above the Fermi energy, to be itinerant in character and to significantly affect the reflectivity measurements of Veal, et al. We find that the 5f bands when included in the RAPW calculations, give excellent agreement with the deHaas-van Alphen results of Boyle and Gold, for all sections of the Lungs, Dumbell and Superegg Fermi surfaces, in contrast with calculations based on artificially removing the 5f resonance. Simple overlap charge density impurity scattering potential model calculations are used to discuss the possible occurrence of impurity local moment formation in Th based alloys. (auth)

3575 PRESSURE EFFECTS ON THE BAND STRUCTURE OF GADOLINIUM. Darby, M. I.; Richardson, N. (Univ. of Salford, Eng.). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 225-226(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

APW calculations of the band structure of gadolinium were made to investigate the effects of decrease in lattice parameters coupled with an increase in c/a ratio. It is found that compared with normal pressure results, decreasing the lattice constants lowers the bottom of the band, and increasing c/a modifies the detailed band structure, particularly near GAMMA. Changes in the density of states were computed and it is found that the Fermi energy is now much closer to the levels near K. It is estimated that the density of states at the Fermi energy, and magnetic properties depending on it, are reduced by 15 percent from normal. (auth)

3576 HYPERFINE ENHANCED NUCLEAR COOLING TO 1.3 mK IN $PrNi_5$. Andres, K.; Schmidt, P. H.; Darack, S. (Bell Labs., Murray Hill, NJ). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 238-239(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Single crystals of $PrNi_5$, were grown which crystallizes in the hexagonal $CaCu_5$ structure, and it was observed that the well-known maximum in the susceptibility occurs only normal to the c-axis, contrary to previous theoretical crystal field predictions. Below 4.2°K, in the Van Vleck paramagnetic regime, the hyperfine enhancement of the local field at the Pr nuclei over the external applied field is 7.0 along the c-axis and 14.5 normal to it. Hyperfine enhanced nuclear adiabatic demagnetization experiments starting from 25 mK and 26 kOe yield end temperatures as low as 1.3 mK. The nuclear specific heat at 1.8 mK is still relatively low, confirming that exchange interactions are small and suggesting that cooling to even lower temperatures should be possible. (auth)

3577 FIELD-INDUCED TRANSITIONS IN DySb. Brun, T. O.; Lander, G. H.; Korty, F. W.; Kouvel, J. S. (Argonne National Lab., IL). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 244-245(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

The NaCl-structured compound DySb, which in zero field transforms abruptly at T/sub N/ approximately 9.5°K to a Type-II antiferromagnetic (A) state with a nearly tetragonal lattice distortion, was previously found to exhibit rapid field-induced changes in magnetization at 1.5°K. The field-induced transitions in a DySb crystal were studied by neutron diffraction and magnetization measurements in fields up to approximately 60 kOe applied parallel to each of the principal axes. In the [100] case, the transition from the A to an intermediate ferrimagnetic (Q) state is first-order at 4.2°K (critical field H/sub c/ approximately 21 kOe) but is continuous from approximately 6 K up to T/sub N/, as H/sub c/ yields 0. The Q-to-paramagnetic (P) transition is rapid but continuous at 4.2°K (H/sub c/ approximately 40 kOe) and becomes broad as T/sub N/ is approached. In the [110] case the A-to-Q transition remains essentially first-order from 4.2°K (H/sub c/ approximately 15 kOe) up to T/sub N/; above T/sub N/ rapid P-to-Q transitions occur at very high fields. The magnetic structure of the Q state is found to be that of HoP. (auth)

3578 GENERALIZED SUSCEPTIBILITY OF Sc METAL. Rath, J. (Northwestern Univ., Evanston, IL); Gupta, R. P.; Freeman, A. J. AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 327-328 (1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

The generalized magnetic susceptibility chi(vector q) of Sc metal was determined from accurate Augmented Plane Wave (APW) method calculations of their energy band structure using a novel computational scheme developed as an extension of the work of Lehmann and Taut and Jepsen and Andersen on the density of states problem. The procedure yields simple analytic expressions for the chi(vector q) integral inside a tetrahedral microzone of the Brillouin zone which depends only on the volume of the tetrahedron and the differences of the energies only at its corners. Constant matrix element results were obtained for Sc which show very good agreement with the results of Liu, Gupta and Sinha and with a first maxima in chi(vector q) at (0,0,0.31)2pi/c vs (0,0,0.35)2pi/c obtained by Liu et al. which relates very well to dilute rare-earth alloy magnetic ordering data vector q/sub m/ equals (0,0,0.28) 2pi/c and to kink in the LA phonon dispersion curve at (0,0,0.27) 2pi/c. (auth)

3579 MAGNETIC PROPERTIES OF URANIUM AND PLUTONIUM LAVES PHASES WITH 3d TRANSITION ELEMENTS. Lam, D. J.; Aldred, A. T. (Argonne National Lab., IL). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 349-350(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Magnetization of UMn_2, UFe_2, UCo_2, UNi_2, $PuMn_2$, $PuFe_2$, $PuCo_2$, and $PuNi_2$ were measured from 4 to 300°K in fields up to 14 kOe. Susceptibility of UMn_2 shows a small maximum near 240°K (which may indicate an antiferromagnetic transition) in agreement with previous results. The data for UFe_2, UCo_2, and UNi_2 are not in good agreement with earlier work; the ferromagnetic ordering temperature (158°K) of a single crystal sample of UFe_2 is lower than any reported value, UNi_2 orders ferromagnetically at 30°K, and UCo_2 may order below 5°K. In contrast, $PuMn_2$, $PuCo_2$, and $PuNi_2$ have small weakly-temperature-dependent susceptibilities. $PuFe_2$ is ferromagnetic at room temperature, in agreement with previous Moessbauer results, and has a saturation moment of approximately 2.6 mu/sub B//mole. (auth)

3580 HIGH-FIELD SUSCEPTIBILITY IN FERROMAGNETIC $NpOs_2$. Dunlap, B. D.; Aldred, A. T.; Lam, D. J.; Davidson, G. R. (Argonne National Lab., IL). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 351-352(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

$NpOs_2$ is known to be a ferromagnet with a Curie temperature of 7.5°K. Previous bulk magnetization measurements indicated a field-induced magnetization even well below the transition temperature. This was extended by a measurement of the local high-field susceptibility, using the Moessbauer effect in ^{237}Np. At 1.6°K, a susceptibility of $(1.2 +- 0.2) \times 10^{-2}$ emu/mole is obtained, in general agreement with the bulk measurement. Such a large susceptibility is best understood by a model of itinerant magnetism, although other properties of the material indicate localized behavior. (auth)

3581 MAGNETIC SUSCEPTIBILITY MEASUREMENTS ON ACTINIDE–Be_{13} INTERMETALLIC COMPOUNDS. Brodsky, M. B.; Friddle, R. J. (Argonne National Lab., IL). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 353-354(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Magnetic susceptibilities were measured between 2 and 300°K for the compounds $AnBe_{13}$ (An equals Th, U, Np, Pu), all of which form the $NaZn_{13}$ structure. The susceptibility of $ThBe_{13}$ is temperature-independent. The data for UBe_{13} and $NpBe_{13}$ may follow two Curie–Weiss regions with the breaks occurring at 200 and

70^{0}K respectively. The Curie–Weiss parameters are not substantially different for the two regimes, p/sub eff/ equals 3.16 and 2.99 mu/sub B/ for UBe_{13}, and p/sub eff/ equals 2.35 and 2.76 mu/sub B/ for $NpBe_{13}$. For $PuBe_{13}$, the Curie–Weiss fit requires a temperature independent term and yields chi_0 equals 1.20×10^{-6} emu/g, P/sub eff/ equals 0.74 mu/sub B//Pu, and theta equals +11^{0}K. The intermediate coupling scheme yields $5f^3$, $5f^4$, $5f^5$, configurations for the U, Np, and Pu compounds, respectively. Thus, each actinide ion is trivalent if the f-electrons are considered to be localized. Of these compounds, only $PuBe_{13}$ gives evidence for long-range magnetic order, becoming antiferromagnetic at T/sub N/ equals 11.5^{0}K. (auth)

3582 MAGNETIC ENTROPY AND MAGNETIZATION OF $ZrZn_2$. Viswanathan, R.; Clinton, J. R. (Univ. of California, La Jolla, San Diego). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 416-417(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

The previously published low temperature heat capacity data of four $ZrZn_2$ samples were analyzed to extract the magnetic entropy, S/sub m/(T). The well-ordered vapor deposited $ZrZn_2$ with T/sub c/ approximately 22^{0}K showed a finite but small S/sub m/(T) of 110 mJ/gm mole^{0}K, indicating that it is very much an itinerant electron ferromagnet. However the dramatic increase of S/sub m/(T) with the increase of Curie temperature suggests that better the samples more the deviation from the Stoner–Wohlfarth band theory. The magnetic measurements carried out on the same samples confirm the general applicability of the band theory and the sensitivity of the samples to the details of preparation and heat treatment. (auth)

3583 FERMI SURFACE "NESTING" IN Tb ALLOYS. Burgardt, P.; Legvold, S. (Ames Lab., IA). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 418-419(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Magnetization and electrical resistivity measurements from 4.2 to 300^{0}K were made on alloys of Tb with Th, Mg, and Yb in order to test valency effects on magnetic ordering in Tb. Tetravalent Th raises E/sub F/ and promotes ferromagnetism by reducing the "nesting" feature in the Tb Fermi surface. Divalent Mg and Yb lower E/sub F/ to enhance the "nesting" feature and promote the helical structure. Results are understood in terms of valency effects on the Fermi surface and impurity size effects. (auth)

3584 MAGNETIC PROPERTIES OF SOME Au_3R COMPOUNDS. Sill, L. R.; Prindiville, B. (Northern Illinois Univ., Dekalb). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 420-422(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

The magnetization of a series of intermetallic compounds Au_3R, where R is Gd through Yb, was investigated at 2.5 to 300^{0}K in applied fields up to 26 kOe. All the compounds studied exhibited the orthorhombic TiCu–Do/sub a/ type structure. For high temperatures, the temperature dependence of the inverse susceptibility followed a Curie–Weiss law, yielding effective paramagnetic moments in good agreement with the values calculated for free tripositive rare earth ions. At low temperatures, deviations from Curie–Weiss behavior were observed in all cases. These deviations are ascribed to the influence of crystal-field and exchange interactions. (auth)

3585 FIELD-INDUCED TRANSITIONS IN $DyAu_2$, $DyAg_2$, $TbAu_2$, AND $TbAg_2$. Kaneko, T.; Ohashi, M.; Miura, S.; Kamigaki, K.; Hoshi, A.; Yoshida, H. (Tohoku Univ., Sendai). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 423-424(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Magnetization of $DyAu_2$, $DyAg_2$, $TbAu_2$, and $TbAg_2$ were measured in pulsed magnetic fields up to 180 kOe and steady fields up to 90 kOe. These compounds exhibit two kinds of magnetically ordered structure: designated by the alpha-state and the beta-state. Two kinds of abrupt change of the magnetization were observed at critical fields, which are considered to correspond to the transition fields from the beta-state to the alpha-state and from the alpha-state to the metamagnetic state, respectively. The magnetization showed a saturation at higher fields. The characteristic feature of the magnetization curves of $DyAg_2$, $TbAu_2$, and $TbAg_2$ are somewhat different from that of $DyAu_2$. The saturation magnetic moment per Dy or Tb ions in these compounds are smaller than those expected for the trivalent ions of Dy or Tb and such a depression of the magnetic moment is due to the effect of the crystalline field. On the basis of these experimental results, the H-T phase diagram of $DyAu_2$, $TbAu_2$ and $TbAg_2$ are proposed. (auth)

3586 NEUTRON SCATTERING AND MAGNETIZATION MEASUREMENTS ON THE KONDO COMPOUND $CeAl_3$. Edelstein, A. S. (Univ. of Illinois, Chicago); Brun, T. O.; Lander, G. H.; McMasters, O. D.; Gschneidner, K. A. Jr. AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 428-429(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202.

Previous measurements on the Kondo compound, $CeAl_3$ (hexagonal DO_{19}), indicate that with decreasing temperature it transforms gradually into a singlet state and does not magnetically order above 0.6^{0}K. To determine the spatial extent of the magnetic moment, the spin-dependent cross section of neutrons diffracted from the (201) planes of a polycrystalline sample in 50 kOe was measured at 5, 19, and 81^{0}K. At 50 kOe and these temperatures, the total moment from magnetization measurements on the same sample is only 5-15 percent lower than the moment determined by the neutrons if one assumes a 4f form factor. This approximate agreement supports the hypothesis that the moment decreases without changing its spatial distribution. A similar spatially uniform reduction of the moment occurs also in dilute Kondo systems. From the field dependence of the magnetization M, the characteristic or Kondo temperature is estimated to be 5.1^{0}K. (auth)

3587 MAGNETIC AND LATTICE PROPERTIES OF CeBi. Lander, G. H. (Argonne National Lab., IL); Mueller, M. H.; Vogt, O. AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 430-431 (1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

The magnetic structures of CeBi were examined as a function of field neutron diffraction. At low fields, unusual domain reorientation effects are observed. For H greater than 18 kOe, a 3+, 1- spin configuration is found. A first-order transition to induced ferromagnetic behavior occurs at 47.5 kOe. X-ray experiments at low temperature show that no lattice distortion occurs at either T/sub N/ equals 25^{0}K or the I–IA transition at 12.5^{0}K. A volume discontinuity is observed at the low temperature transition. (auth)

3588 NEGATIVE MAGNETORESISTANCE IN HIGH-MAGNETIC-FIELD BCC TITANIUM ALLOY SUPERCONDUCTORS. Lue, J. W.; Montgomery, A. G.; Hake, R. R. (Indiana Univ., Bloomington, IN). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 432-434(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Weak normal-state negative magnetoresistance and negative slope d rho/dT in the electrical resistivity rho versus T were observed at temperatures 1,2 less than or equal to T less than or equal to 27^{0}K and applied magnetic fields H less than or equal to 140kG in very short electron-mean-free-path, superconducting, bcc Ti-base alloys such as $Ti_{92}Fe_8$, $Ti_{86}Mn_{14}$, $Ti_{92}Ru_8$, $Ti_{84}Mo_{16}$, $Ti_{92}Os_8$. This suggests that conduction electrons may interact with compensated or fluctuating localized spins, as might also account for the characteristic high rho and negative d rho/dT at approximately 10 less than T less than 300K, H equals 0. (5 figures) (auth)

3589 HYPERFINE FIELDS IN Nd_2Co_{17}, $NdCo_5$, AND $NdCo_3$. Streever, R. L. (Electronics Technology and Devices Lab. (ECOM), Fort Monmouth, NJ). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 462-463(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

NMR of ^{59}Co, ^{143}Nd, and ^{145}Nd was studied at 4.2^{0}K in the compounds Nd_2Co_{17}, $NdCo_5$, and $NdCo_3$. Co hyperfine fields in these alloys are found to depend on both the alloy and the Co site within a given alloy and vary from 30 to 220 kG. The Nd hyperfine fields are found to be in the range from 3.4–4.0 MG. (auth)

3590 MAGNETIC ORDERING IN PdGd: ELECTRICAL RESISTIVITY AND MAGNETIC SUSCEPTIBILITY. Cannella, V. (Wayne State Univ., Detroit); Burch, T. J.; Budnick, J. I. AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 464-465(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Temperature dependences of the electrical resistivity rho (T) and the low field magnetic susceptibility chi (T) for PdGd containing up to 5 at. percent Gd. For alloys containing 2, 3, and 5 at. percent Gd, rho (T) shows a sharp reduction in the spin disorder

scattering at the ferromagnetic Curie temperature T/sub c/, obtained from chi (T). Previous electrical resistivity measurements failed to exhibit the effect of magnetic ordering because the high field estimates of T/sub c/ used were significantly larger than the present values. Resistivity data yield estimates of the conduction electron-local moment exchange interaction to be approximately .003 eV. (auth)

3591 SKEW SCATTERING AND QUADRUPOLE SCATTERING BY RARE EARTH IMPURITIES IN SILVER, GOLD, AND ALUMINUM. Fert, A.; Friederich, A. (Paris Univ., Orsay, France). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 466-471 (1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Mechanisms of the skew scattering and of the quadrupole scattering which are shown by Hall effect and magnetoresistance measurements on silver, gold, and aluminum containing rare earth impurities are discussed. (auth)

3592 BGS RELAXATION IN THE DILUTE ALLOYS La : In. Schreiber, D. S.; Wade, R. F. (Univ. of Illinois, Chicago). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 472-474(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202.

The enhanced relaxation rates $1/T_1$ of ^{139}La in dilute alloys La : Ln, Ln equals Ce, Pr, Nd, Gd, or Lu were measured and the electronic moment life times deduced. (auth)

3593 MAGNETIC SUSCEPTIBILITY STUDY OF THE CONTINUOUS DEMAGNETIZATION OF Ce IMPURITIES IN THE (La, Th)Ce SYSTEM. Huber, J. G.; Brooks, J.; Wohlleben, D.; Maple, M. B. (Univ. of California, San Diego, La Jolla). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 475-476(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Measurements of the magnetic susceptibility as a function of temperature are reported for the (La,Th) Ce system which document directly the continuous demagnetization of Ce impurities which proceeds with increasing Th composition. (auth)

3594 FERROMAGNETIC RESONANCE RELAXATION PROCESSES IN Zn_2Y. Mita, M.; Shimizu, H. (Univ. of Tokyo). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 514-515(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974) See CONF-741202-.

Experimentally obtained linewidth in F.M.R. of Zn_2Y is analyzed numerically on the basis of two-magnon, three-magnon, and four-magnon relaxation processes. In the analyzing procedure of three-magnon linewidth, the effective exchange constants are determined to be D/sub perpendicular/ equals 0.15×10^{-9} Oe cm^2 and D/sub parallel parallel/ equals 9.3×10^{-9} Oe cm^2 within and between the crystallographic c planes. The two-magnon linewidth induced by surface imperfections is discussed in consideration of scattering due to multipole demagnetizations of the imperfections. The four-magnon linewidth is observed for the first time and analyzed successfully. (auth)

3595 TERNARY AMORPHOUS ALLOYS FOR BUBBLE DOMAIN APPLICATIONS. Chaudhari, P.; Cuomo, J. J.; Gambino, R. J.; Kirkpatrick, S.; Tao, L. J. (IBM Research Center, Yorktown Heights, NY). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 562-563(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

The drive field for bubble domain propagation in T-bar devices is proportional to 4 pi M/sub s/. From the definitions of the characteristic length, l, and of Q it can be shown that 4 pi M/sub s/ is proportional to AQ, where A is the exchange stiffness. It was found that the magnetic properties of ternary amorphous systems of the type Gd–Co–X, where X is a nonmagnetic element, eg. Au, Cu, Mo, can be fine-tuned for bubble device applications. It is possible to lower A by magnetic dilution as well as adjust 4 pi M/sub s/ by varying the Co/Gd ratio as in the binary system. (auth)

3596 POLAR KERR ROTATION AND SUBLATTICE MAGNETIZATION IN GdCoMo BUBBLE FILMS. Argyle, B. E.; Gambino, R. J.; Ahn, K. Y. (IBM Research Center, Yorktown Heights, NY). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 564-566(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Kerr rotation in Gd–Co–Mo alloys is due mostly to the cobalt atoms. Polar Kerr loops vs composition and temperature were investigated, and total magnetization (from initial loop susceptibility and domain size) and the cobalt sublattice magnetization (from the saturation Kerr rotation angle) were determined. Deviations from the characteristic Kooy and Enz loop behavior due to thin approximately 100 A surface layer anomalies are first identified and removed in order to analyze the bulk film behavior. (auth)

3597 ANNEALING BEHAVIOR OF AMORPHOUS Gd–Co–Mo THIN FILMS. Kobliska, R. J.; Gangulee, A. (IBM Research Center, Yorktown Heights, NY). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 567-569(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Long-term thermal stability is a prerequisite for bubble film materials. Results of an investigation of the isothermal annealing behavior of amorphous Gd–Co–Mo thin films, in the temperature range 150 to 350^{0}C, are reported. All functional magnetic properties were retained by these films even after annealing at 350^{0}C. The room-temperature magnetization and the stripe collapse field decreased upon annealing and then stabilized, the magnitude of the decrement depending on the annealing temperature. The activation energy associated with the annealing process is about 0.4 eV. Results are interpreted in terms of corresponding changes in the compensation temperature, and they indicate that stabilization of the magnetic properties prior to bubble device fabrication may be a desirable process step. (auth)

3598 UNIAXIAL ANISOTROPY IN RARE EARTH (Gd, Ho, Tb): TRANSITION METAL (Fe, Co) AMORPHOUS FILMS. Heiman, N.; Onton, A.; Kyser, D. F.; Lee, K.; Guarnieri, C. R. (IBM Research Lab., San Jose, CA). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 573-574(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Evidence is presented that magnetic uniaxial anisotropy in amorphous RE–TM films is a more common feature than had been presumed. The incident atomic beam direction appears to define the anisotropy axis in thermally evaporated films while the electric field direction at the surface is the dominant influence in bias sputter deposition. The nature of the coupling of the magnetization to the structural anisotropy is also found to vary. (auth)

3599 REVERSAL OF HALL EFFECT AND KERR ROTATION IN FERRIMAGNETIC RARE EARTH–COBALT SYSTEMS. Ogawa, A. (Univ., Tokyo); Katayama, T.; Hirano, M.; Tsushima, T. AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 575-576(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Hall effect in the ferrimagnetic systems of rare earth(R) and cobalt(Co) such as Gd_2Co_7 and its temperature dependence, especially near compensation temperature, is investigated both theoretically and experimentally. The polarity of the Hall voltage in these materials is reversed at the compensation temperature, and it is similar to the reversal in optical Kerr effect. The anomalous part of the Hall voltage is separated theoretically into two independent parts; one is of R and the other of Co. The contribution of R to the observed Hall voltage is considered to be several hundreds times larger than that of Co in the ferrimagnetic temperature region by taking the quite large spin-orbit interaction of R into account, and the reversal of the Hall voltage at the temperature is explained essentially in terms of the anomalous Hall effect originated dominantly from R. On the other hand, the variation of Kerr rotation with temperature comes mainly from Co in the visible region. (auth)

3600 MAGNETOELASTIC COUPLING IN PARAMAGNETIC DYSPROSIUM. Kale, B. M.; Donoho, P. L.; Pinatti, D. G.; Ferreira, O. (Universidade Estadual de Campinas, Brazil). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 651-652(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

The dependence of the elastic constants c_{11} and c_{33} on temperature and applied magnetic field was measured for single-crystal paramagnetic dysprosium, in an effort to determine the magnetoelastic coupling constants. Magnetostrictive corrections were made. The magnetoelastic coupling constants, following the theory of Southern and Goodings, are considerably larger then expected; those estimated from the static magnetostriction results of Clark et al. are smaller by a factor of about 20. A possible reason for

this large difference between the statically and dynamically determined values for the magnetoelastic coupling constants may lie in the assumption by Southern and Goodings that the principal magnetoelastic contribution to the elastic constants arises from the inclusion of the nonlinear terms in the conventional definition of the finite strain tensor in the lowest order terms of the magnetoelastic Hamiltonian. (auth)

3601 MAGNETOELASTIC ULTRASONIC GENERATION IN $TbFe_2$ THIN FILMS. McLane, L. B. (Rockwell International, Inc., Dallas); Donoho, P. L.; Wimbush, W. L. AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 653-654(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Ultrasonic elastic waves were magnetostrictively generated at room temperature in polycrystalline films of $TbFe_2$ deposited on quartz and sapphire substrates at a frequency of 690 MHz. The maximum generation efficiency was approximately 50 times that of nickel films deposited under similar conditions. In the case of deposition at substrate temperatures above 320°C, the films exhibited a strong magnetic anisotropy, with the easy axis invariably perpendicular to the plane of the film. This anisotropy led to coercive forces as high as 6 kOe and remanent magnetizations as high as 80 percent of the saturation magnetization. As a result, efficient generation of elastic waves could be achieved in films with no applied field if they had previously been magnetized. The field dependence of the ultrasonic generation and the magnetic anisotropy were found to be strongly dependent on the film thickness and on certain deposition parameters, particularly the substrate temperature, as indicated above. Annealing of the films subsequent to deposition also affected strongly the anisotropy and the ultrasonic generation efficiency. In all cases, however, the magnetic easy axis was perpendicular to the plane of the film (it should be pointed out that deposition was not carried out in the presence of a field). (auth)

3602 MAGNETOELASTICALLY DRIVEN DOMAIN WALL RESONANCE AT MAGNETIC TRANSITIONS. Vigren, D. T. (Freie Univ., Berlin). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 658-659(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

It is proposed that magnetoelastically driven domain wall resonance is the mechanism by which ultrasonic waves are absorbed near the ferromagnetic-spiral transition of Dy and Tb. Good agreement with the measured attenuation coefficient is obtained on the basis of a simple model. In Ho, shear attenuation peaks observed at 24°K as well as some low-temperature structure in the longitudinal attenuation appear to be due to this same mechanism. (auth)

3603 MOESSBAUER AND X-RAY STUDY OF THE SELF-INDUCED MAGNETOSTATIC DISTORTION OF Tb/sub x/Y/sub 1-x/Fe_2 LAVES PHASES. Preston, R. S.; Dwight, A. E.; Fedro, A. J.; Kimball, C. W. (Northern Illinois Univ., DeKalb). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 660-661(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

A comparison was made between x-ray diffraction data and Moessbauer absorption data for a series of ferrimagnetic compounds Tb/sub x/Y/sub 1-x/Fe_2. Previous work has shown that the volume and the rhombohedral angle of the distorted "cubic" unit cell both vary with the Tb concentration x, but that the distortion disappears for x less than or equal to 0.25. Since this is close to the concentration where the rare-earth and the iron sublattice magnetizations are equal and opposite, a detailed study of the ^{57}Fe Moessbauer spectra was made for these compounds in the vicinity of x equals 0.25. Results confirm the previous finding that the magnetic hyperfine field varies continuously with the Tb concentration. Also, they reveal that the Fe sites are not all equivalent chemically and crystallographically, and that this is true whether or not the rhombohedral distortion is present. This suggests that in addition to the rhombohedral distortion there may be an independent distortion or shiftipg of the iron tetrahedra within the unit cube. (auth)

3604 SPIN REORIENTATION STUDIES IN CUBIC LAVES RARE-EARTH IRON COMPOUNDS. Atzmony, U.; Dariel, M. P. (Nuclear Research Center, Beersheba, Israel). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 662-663(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Several types of spin reorientation occur in Ho/sub x/Er/sub 1-x/Fe_2, particularly that from the [110] toward the [100] direction. In all cases the general behavior of the hyperfine fields at the inequivalent iron sites is well accounted for by magnetic dipolar contributions. Analysis of the Moessbauer spectra taken in the spin rotation temperature interval indicates that the easy axis of magnetization deviates from the axes of symmetry of the cubic system. In the [110] to [111] rotation the spin is in the (1 anti 10) plane, while in the [110] to [100] transition it rotates continuously within the (001) plane. (auth)

3605 STRESS DEPENDENCE OF THE MAGNETIC SUSCEPTIBILITY IN PRASEODYMIUM BETWEEN 1.5 K AND 25 K. Ott, H. R. (Laboratorium fuer Festkorperphysik, Zurich). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 664-665(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

The magnetostriction parallel and perpendicular to the hexagonal axis of single crystal Pr was measured in magnetic fields up to 10 kOe. From these measurements, the stress dependence of chi /sub parallel/ and chi/sub perpendicular/ were determined. The relative stress dependences delta ln chi/sub parallel//delta sigma/sub c/ and delta ln chi/sub perpendicular//delta sigma /sub a/ are of the same order of magnitude. The data can be used to calculate the influence of changes of the axial ratio c/a on chi /sub parallel/ and to estimate the same property of chi/sub perpendicular/. From these results it is concluded that the anisotropy of chi below 30°K can only partly be explained with the strong variation of rho (rho equals c/a) below that temperature, and the increase of chi/sub perpendicular//chi/sub parallel/ with decreasing temperature is mainly due to crystal field effects as suggested by Rainford. It also seems very unlikely that the observed ordering effects in polycrystalline Pr are due to strain effects in these samples. (auth)

3606 MAGNETIC-ANNEAL-INDUCED UNIAXIAL ANISOTROPY IN $TbFe_2$. Schelleng, J. H.; Koon, N. C. (Naval Research Lab., Washington, DC). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 668-669(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Low-temperature magnetic measurements were made on polycrystalline samples of $TbFe_2$. Hysteresis curves taken after the material was cooled to temperatures below 80K in the presence of a field were found to be oddly distorted when the measuring field direction and the annealing field direction differed. This behavior can qualitatively be explained in terms of a model based on the high cubic anisotropy and magnetostriction existing in this material, plus an added, anneal-induced uniaxial anisotropy. Activation energy studies at the annealing temperature indicate that dislocations are involved in the annealing process. (auth)

3607 MAGNETOSTRICTION OF SINGLE CRYSTAL AND POLYCRYSTAL RARE EARTH-Fe_2 COMPOUNDS. Clark, A. E. (Naval Ordnance Lab., White Oak, MD); Cullen, J. B.; Sato, K. AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 670-671(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Magnetostriction measurements on single crystal and polycrystal $TbFe_2$ and $ErFe_2$ are reported and compared. For $TbFe_2$, the largest known room temperature magnetostriction constant is found: lambda/sub 111/ equals 2400×10^{-6}. For $ErFe_2$: lambda /sub 111/ equals -300×10^{-6}. Lambda/sub 111/ is the dominant magnetostriction constant and the major source of the magnetostriction of the polycrystalline rare earth-Fe_2 alloys. $TbFe_2$ possesses the larges known cubic anisotropy constant. At room temperature K_1 equals -7.6×10^7 erg/cm^3. The sign of the anisotropy plays an important role in determining the field dependence of the polycrystalline magnetostriction. (auth)

3608 MAGNETIZATION AND MAGNETIC ANISOTROPY IN Lu/sub x/Tm/sub 2-x/Co_{17} INTERMETALLICS. Miller, A. E.; Miura, K.; Rodrigues, H.; D'Silva, T. (Univ. of Notre Dame, IN). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 672-673(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

The temperature and field dependence of the magnetization of the hexagonal intermetallic compounds, Lu/sub x/Tm/sub 2-x/Co_{17} (x equals 0, 2/3, 4/3, 2) was determined as a function of crystallographic direction. All specimens were single-crystal spheres, and measurements were made in the temperature range 77.4 to 450°K in applied fields up to 13 KOe. The anisotropy constants K_1 and K_2 were determined and the anisotropy behavior was found to obey the single ion model. (auth)

3609 PROPERTIES OF MICROSAMPLES OF SINTERED COBALT-SAMARIUM MAGNETS. Becker, J. J. (General Elec-

tric Research and Development Center, Schenectady, NY). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 676-677(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Hysteresis loops of small but still multi-grain samples taken from sintered Co_5Sm magnets show a wide range of behavior, samples from the same magnet bracketing the bulk properties. Magnetization discontinuities often appear and are associated with large grains. These jumps show a quantized dependence of jump field on magnetizing field and often a good 1/cos theta dependence, exactly as in particles prepared from cast material. A sample consisting of only one grain gave a completely rectangular loop. Measurements on sintered magnets indicate that large grains tend to reverse in small fields, detracting from the overall properties. (auth)

3610 LOW TEMPERATURE MAGNETIC HARDNESS IN SUBSTITUTED $SmCo_5$. Oesterreicher, H. (Univ. of California, San Diego, La Jolla); McNeely, D. AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 678-679(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

The mechanism of magnetization at liquid He temperatures is investigated in alloys based on $SmCo_5$ with partial substitution for Co by Ni, Ag, Al and Si. Further materials $Y_{0.167}Co_{0.683}Al_{0.15}$ and $Gd_{0.167}Co_{0.683}Al_{0.15}$ are included. Only homogeneous specimens of $CaCu_5$ type are studied. Al and Si substituted materials when obtained by quenching from the melt exhibit stacking fault structures in the basal plane. These materials show, at 4.2°K, outstanding coercive forces in bulk and powder form (with extrapolated values of about 60 kOe at the phase boundary $Sm_{0.167}Co_{0.808}Al_{0.25}$). When bulk alloys are annealed (700°C) demagnetization takes place spontaneously at critical fields with a slope comparable to the demagnetization factor rather than with the considerably smaller slope found in materials prepared by quenching from the melt. Ni and Ag substituted $SmCo_5$, as well as $Y_{0.167}Co_{0.683}Al_{0.15}$ and $Gd_{0.167}Co_{0.683}Al_{0.15}$ show no appreciable coercive forces at 4.2°K. Results are discussed in terms of a model of homogeneous pinning of domain walls of atomic dimensions on the crystal lattice. The role of substituent and rare earth in establishing highly energetic domain walls is discussed. (auth)

3611 EVIDENCE FOR NEW MAGNETIC RARE EARTH-COBALT PHASES. Strnat, K. J.; Ray, A. E. (Univ. of Dayton, OH). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 680-682(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

An infinite series of hypothetical intermetallic compounds, with compositions converging toward RCo_5, can be derived by c-axis stacking of RCo_5 cells and selective substitution of R atoms for Co: RCo_2, RCo_3, R_2Co_7, R_5Co_{19}, RCo_4, R_7Co_{29}, R_4Co_{17}, R_3Co_{12}, R_5Co_{22}..... The first three compound types are well known. R_5Co_{19} phases were recently found for R equals La, Ce, Pr, and Nd. Dynamic permeability vs temperature measurements (-190 to +700°C) on several RCo/sub x/ alloys with R equals La, Ce, Pr, Nd, and Sm in the range 3.5 less than x less than 5 yielded Curie points for the R_5Co_{19} and indicated the existence of several more phases. From the observed distinct permeability peaks, Curie temperatures are determined and compared with expected values based on the compositions of the above phases. No discrete peaks were observed for Sm-Co, but a broad maximum between the Curie temperatures of Sm_2Co_7 and $SmCo_5$ indicates that certain heat treatments produce intermediate, disordered structures. (auth)

3612 STRUCTURE TRANSFORMATIONS IN SPUTTER-DEPOSITED Sm_2Co_{17} ALLOYS. Wang, R.; Allen, R. P. (Battelle Pacific Northwest Labs., Richland, WA). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 683-684(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

A series of structure transformations were observed for thick, sputter-deposited amorphous Sm_2Co_{17} alloys heat treated between 500 and 900°C for one hour. The amorphous phase crystallized at approximately 500°C to give a $CaCu_5$-type structure with a c/a ratio of 0.86, which is the highest value ever observed for these alloys. With increasing annealing temperature, the c parameter decreased and the a parameter increased resulting in a continuous reduction of the c/a ratio to a value of 0.84 at 800°C, which is the same as that of the Th_2Zn_{17}-type structure. These structure transformations and lattice parameter variations are attributed to a progressive change with annealing in the number and degree of order of Sm-atom/Co-atom pair substitutions. Based on a correlation found between the c/a ratio and composition for the $CaCu_5$-type Sm-Co alloys, the metastable phase crystallized from the amorphous state at 500°C has an approximate formula of Sm_2Co_{24} to Sm_2Co_{26}. (auth)

3613 MECHANISM FOR COERCIVITY IN SPLAT-COOLED RCo_5 COMPOUNDS. Ziai, E.; Kim, Y. B. (Univ. of Southern California, Los Angeles). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 685-686(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Splat-cooling technique is used to prepare fine powders of certain RCo_5 compounds. Powders produced in this way are free from most of the defects that are introduced in powders prepared by mechanical grinding. Furthermore, splat-cooled materials are shown to have large concentrations of grain boundaries. These powders have magnetic properties which are different from those of the powders produced by mechanical comminution. In particular, the intrinsic coercivities of $PrCo_5$ and $MMCo_5$ are increased significantly by splat cooling, while their maximum energy products are reduced. Heat treatments of splat-cooled powders, which reduces the density of grain boundaries, increases coercivity slightly but a large increase takes place in the maximum energy product. Mechanical grinding of splat-cooled materials produces similar effects, although this time it is due to the deliberate introduction of defects which act as pinning centers. By analyzing the hysteresis curves of as-ground, splat-cooled and heat-treated or ground splat-cooled $SmCo_5$, it is concluded that in the splat-cooled materials a nucleation mechanism is dominant in the initial stages of the magnetization reversal process. Nucleation takes place at the grain boundaries which are in abundance. (auth)

3614 PREPARATION AND CHARACTERIZATION OF SPLAT-COOLED R-Co COMPOUNDS. Ratnam, D. V. (Crucible Materials Research Center, Pittsburgh); Narashimhan, K. S. V. L.; Giessen, B. C. AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 687-688(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Rapidly quenched alloys of Sm-Co, Pr-Co, and MM-Co of the approximate composition RCo_5 were prepared by splat cooling droplets of the alloys in a modified arc furnace. X-ray diffraction analysis indicated a fine grained structure and also the possibility of some texture in the splat-cooled samples. Microscopic examination of the alloys in a light microscope revealed an equiaxed fine grained structure with a grain size of 2 to 5 mu m. Magnetic measurements were performed on a vibrating sample magnetometer. Coercive force values were 5000 Oe for $SmCo_5$, 1500 Oe for $PrCo_5$, and 1250 Oe for $MMCo_5$. Thermomagnetic curves were obtained on the splat-cooled alloys by plotting magnetization versus temperature up to 900°C. The data indicated that all the alloys were single phase with Curie points in fair agreement with published values for these compounds. Splat-cooled $PrCo_5$ was found to be unstable near its Curie temperature. (auth)

3615 PLASMA SPRAYED SMARIUM-COBALT PERMANENT MAGNETS. Willson, M. C.; Janowiecki, R. J. (Monsanto Research Corp., Dayton, OH). AIP (Am. Inst. Phys.) Conf. Proc., No. 24, 689-690(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

Samarium-cobalt permanent magnets were fabricated by arc plasma spraying. This process involves the injection of relatively coarse powder particles into a high-temperature gas for melting and spraying onto a substrate. The technique is being investigated as an economical method for fabricating cobalt-rare earth magnets for advanced traveling wave tubes and cross-field amplifiers. Plasma spraying permits deposition of material at high rates over large areas with optional direct bonding to the substrate, and offers the ability to fabricate magnets in a variety of shapes and sizes. Isotropic magnets were produced with high coercivity and good reproducibility in magnetic properties. Post-spray thermal treatments were used to enhance the magnetic properties of sprayed deposits. Samarium-cobalt magnets, sprayed from samarium-rich powder and subjected to post-spray heat treatment, displayed energy products in excess of 9 million gauss-oersteds and coercive forces of approximately 6000 oersteds. Bar magnet arrays were constructed by depositing magnets on ceramic substrates. (auth)

3616 MAGNETIC PROPERTIES OF R(Co/sub 1-y/Cu/sub y/)/sub z/ COMPOUNDS. Perkins, R. S.; Perry, A. J.; Nagel, H.; Menth, A. (Brown Boveri Research Center, Baden, Switzerland). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 693-694(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

The hard magnetic characteristics of compounds having composition Sm(Co/sub 1-y/Cu/sub y/)/sub z/ and lying within the phase space 5·0 less than or equal to z less than or equal to 8·5, 0 less than or equal to y less than or equal to 1·0, are strongly influenced by the nature of their metallurgical microstructure. However, by measurement of the anisotropy field, domain size, and angular dependence of the coercivity, and in conjunction with data obtained from transmission electron microscopy, as well as the implications of a theoretical model for the coercivity in these materials, and simple arguments concerning the diluting effect of copper upon the primary magnetic properties of the constituent phases, the principal features of this group of materials may be clarified. (auth)

3617 PERMANENT MAGNETS ON THE BASIS OF $MMCo_5$ AND THE RELATION BETWEEN THEIR PROPERTIES AND THE PRIMARY MAGNETIC PROPERTIES OF THESE COMPOUNDS. Nagel, H.; Klein, H. P. (Brown Boveri Research Center, Baden, Switzerland). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 695-696(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

The permanent magnetic properties of MM/sub 1-x/Sm/sub x/Co_5 magnets, prepared by powder-metallurgical means, were studied in the range 0 less than X less than 0,4 and for various chemical compositions of MM. For both coercivity and energy product, a nearly linear dependence on the samarium content was found in the range investigated. Moreover, there is a very strong correlation between the permanent magnetic properties and the composition of the MM. By optimizing this composition, $MM_{0.85}Sm_{0.15}Co_5$ magnets can be produced with a coercivity /sub I/H/sub C/ greater than 16 kOe and H/sub K/ greater than 14 kOe respectively, and a maximum energy product of up to 18 MGOe. These values are discussed with respect to the primary magnetic properties of these compounds as obtained from single crystal measurements. (auth)

3618 OPTIMIZING THE COMBINATION OF MAGNETIC INDUCTION AND YIELD STRENGTH OF VANADIUM PERMENDUR BY HEAT TREATMENT. Fiedler, H. C. (General Electric Co., Schenectady, NY). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 739-740(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

The high magnetic saturation of Vanadium Permendur, a soft magnetic alloy of 2 percent vanadium, 49 percent cobalt, and 49 percent iron, makes this alloy particularly useful for laminations in generators and motors when weight is important. The normal heat treatment used to optimize the magnetic properties of this alloy produced a yield strength that was substantially below that required for the high speed rotor of a generator. Described are the results of a study of the relationship between microstructure and magnetic properties, and of the development of a heat treatment that provides a suitable combination of strength and high induction. (auth)

3619 INFLUENCE OF HEAT TREATMENT ON MAGNETIC PROPERTIES OF A SOFT IRON COBALT ALLOY. Moses, A. J. (Univ. of Wales, Cardiff). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 741-742(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

The alloy containing 49 percent Co, 49 percent Fe, and 2 percent V, is extremely sensitive to the type of heat treatment carried out after fabrication. Changes in magnetic properties by varying the heat treatment temperature from 450 to 800°C are shown. The variation of ac magnetostriction and power loss are discussed in terms of changes in anisotropy, magnetostriction constants, and structure. The material is sensitive also to mechanical stresses. Tension or compression applied parallel to the magnetizing direction produce the largest changes. After final heat treatment at temperatures above 700°C, compressive stress increases the power loss whereas tensile stress has little effect. After annealing between 450 and 700°C, tensile stress can have a harmful effect and at some flux densities (up to about 1,0T) a "stress after effect" is present as indicated by a gradual change in loss after a stress is removed from a sample. (auth)

3620 ELECTRON MICROSCOPIC STUDY OF THE ORIGIN OF COERCIVITY IN AN Fe–Co–V ALLOY. Mahajan, S.; Olsen, K. M. (Bell Labs., Murray Hill, NJ). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 743-744(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

To ascertain the origin of coercive force in an Fe–Co–V alloy (2,91 wt percent V, Fe equals Co), a transmission electron microscopic study was made of the microstructures and domain wall configurations after the following treatments: A_1 equals cold rolled to 97 percent reduction + strand annealed for 30 s at 950°C + aging at 600°C for 2 h; A_2 equals treatment A_1 + 5 s at 1050°C; A_3 equals treatment A_1 + 5 s at 950°C; A_4 equals treatment A_1 + 5 s at 850°C. The values of coercive force are 25, 32, 38, and 13 Oe, respectively. The microstructure of A_1 samples shows precipitation within some grains. Lorentz microscopy reveals that domain walls are pinned by these precipitates. No precipitation is observed in A_2 samples, and instead they exhibit substructures characteristic of a structural transformation. The interaction between the transformation-induced substructure and domain walls appears to be weak. The structure of A_3 and A_4 samples consists of grains having relatively low and moderately high dislocation density. In A_3 samples, domain walls tend to lie along the interfaces of the latter grains and rarely penetrate them. It is envisioned that the overall coercivity of A_4 samples is lower because the volume fraction of the high dislocation density grains as well as the magnitude of internal strain are lower. (auth)

3621 DETERMINATION OF THE TEMPERATURE DEPENDENCE OF THE MOBILITY RATIO b BY MEASURING THE TRANSVERSE NERNST-ETTINGSHAUSEN EFFECT. TEMPERATURE DEPENDENCE OF b FOR InSb. Somogyi, K. (Institute of Technical Physics, Hungarian Academy of Sciences, Budapest). Sov. Phys.—Semicond. 9: No. 4, 474-478 (Apr 1975).

A method is suggested for the determination of the ratio of the electron and hole mobilities and of the temperature dependence of this ratio in the mixed and intrinsic conduction regions of a semiconductor. This method is based on the determination of the temperature dependences of the Hall coefficient, electrical conductivity, and transverse Nernst–Ettingshausen effect. General and simplified equations are given for weak and classically strong fields of practical interest and for a field which is strong for electrons but weak for holes. These equations relate the required and measured quantities. The results are given of the application of this method to the determination of the temperature dependences of the values and ratio of the electron and hole mobilities in n- and p-type InSb. (auth)

3622 OBSERVATION OF AN ADDITIONAL CYCLOTRON RESONANCE PEAK DUE TO IMPURITY ELECTRONS IN *n*-TYPE InSb. Smirnova, V.B. (V. I. Lenin State Pedagogical Institute, Moscow). Sov. Phys.—Semicond. 9: No. 4, 445-446 (Apr 1975).

A study was made of cyclotron resonance in n-type InSb in magnetic fields H = 10–20 kOe at liquid-helium temperatures and a peak was found in addition to the N = 0(↑) → N = 1(↑) free-electron and (000) → (010) impurity-electron transitions. This additional peak was attributed to the (000) → (011) transition. (auth)

3623 DENSITIES OF FREE AND BOUND ELECTRONS AND CHARACTERISTICS OF CYCLOTRON RESONANCE IN PURE *n*-TYPE InSb IN QUANTIZING MAGNETIC FIELDS. Gershenzon, E.M.; Litvak-Gorskaya, L.B.; Serebryakova, N.A.; Smirnova, V.B. (V. I. Lenin State Pedagogical Institute, Moscow). Sov. Phys.—Semicond. 9: No. 4, 440-444 (Apr 1975).

The densities nf of free and bound electrons in pure n-type InSb were determined as a function of the applied magnetic field H and temperature (T = 6.5-2°K). The fall of nf with rising H and the dependence of the donor impurity ionization energy on the magnetic field, $\epsilon_d(H)$, were in agreement with calculations. The cyclotron resonance observed at temperatures $T < 4.2$°K in fields $H > 10$ kOe was influenced strongly by transitions from the $(0\bar{1}0)$ first excited impurity state. (auth)

3624 EFFECTS OF HYDROGEN ON THE MATRIX STRUCTURE IN $(Ta_{0.35}Ti_{0.65})H_{0.35}$. Katsnel'son, A.A.; Stupina, N.N.; Miron, N.F.; Bykov, V.N.; Levdik, V.A. Sov. Phys.—Crystallogr. 20: No. 2, 262-262 (Mar 1975).

Variations in diffuse x-ray scattering intensities observed in $Ta_{0.35}Ti_{0.65}$ and $(Ta_{0.35}Ti_{0.65})H_{0.35}$ indicate that the introduction of interstitial H atoms into the initially disordered $Ta_{0.35}Ti_{0.65}$ produces some short-range order. (AIP)

3625 TRANSFORMATION CURVES OF THE U–Zr, U–Cr, U–Fe, U–Mo, U–Nb, AND U–V BINARY SYSTEMS. Wozniakova, B.; Kuchar, L. Sb. Ved. Pr. Vys. Sk. Banske Ostrave, Rada Hutn.; 19: No. 2, 9-27(1973). (In Czech).

The results of a systematic study of the transformation of the binary systems of U with Zr, Cr, Fe, Mo, Nb, and V are presented. The equations of the transformation/temperature curves, their range of validity, values of the equilibrium distribution coefficient of transformation at temperature approaching the

tranformation temperature of U, and for the eutectoid temperature are indicated. (Metal Abstr.)

3626 ELECTRICAL RESISTANCE OF VANADIUM–GOLD ALLOYS. Gold Bull.; 7: No. 3, 77(Jul 1974).
A review of studies on the effect of 3d transitional impurities on the resistivity of Au is given. The unusually high resistivity of Au alloys containing V 0.8 to 2.0 at.-% can only partly be explained by a two-band electronic model. (Metals Abstr.)

3627 HIGH-TEMPERATURE RESISTANCE OF RESISTIVITY-HEATED WIRES. Gaal, I.; Neugebauer, J. M.; Uray, L. Acta Tech. Acad. Sci. Hung.; 78: No. 3/4, 371-392(1974).
The increase in electrical resistance of W wires caused by nonconducting second phases, grain boundaries, and dissolved impurities, is considered. The increases in resistivity caused by Fe, Ti, Nb, Re, Mo, and C impurities in W at 4.2°K are tabulated. The effect of the emissivity on the temperature of resistance-heated W wire filaments is described. (Metals Abstr.)

Radiation Effects

Refer also to abstract 4516.

3628 (CONF-751006-12) SUPPRESSION OF VOID FORMATION IN NICKEL BY A DYNAMIC TRAPPING MECHANISM. Sorensen, S. M. Jr.; Chen, C. W. (Ames Lab., Iowa (USA)). 1975. 7p. Dep. NTIS $4.50.
From international conference on radiation damage in metals; Gatlinburg, Tennessee, USA (5 Oct 1975).
The effect of carbon on void formation in high purity nickel under neutron irradiation to four fluences ranging from 4×10^{19} to 2×10^{20} n/cm^2 (E greater than 0.1 MeV) at 500°C was investigated using transmission electron microscopy. In samples containing up to 84 wt ppM C, cubic voids were observed, and the void size tended to increase with increasing C content, while the void density decreased at much greater rates. Consequently, the associated swelling was seen to be steadily reduced. In samples containing 600 ppM C, void formation was completely suppressed, and an irradiation-induced dissolution of graphite precipitates occurred. The suppression of void formation in the irradiated Ni is attributed to an effective trapping mechanism associated with the interstitial C atoms in solution. Quantitative analyses on the size and density of voids reveal that the suppressing effect of C is mainly on void nucleation, not on growth. This trapping mechanism is considered to be dynamic in nature because the traps served by the C atoms can move through the lattice rapidly during irradiation until they are anchored in defect complexes. (auth)

3629 (UCRL-77345) STAGE III DISLOCATION PINNING IN SILVER RESULTING FROM GAMMA IRRADIATION. Van Konynenburg, R. A.; Guinan, M. W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Sep 1975. 9p. (CONF-751006-8). Dep. NTIS $4.00.
From international conference on radiation damage in metals; Gatlinburg, Tennessee, USA (5 Oct 1975).
The objectives of this work were fourfold: (1) to test the validity of the vibrating string dislocation model in silver, (2) to determine in which annealing stage long-range migration first occurs, (3) to measure the migration energy and identify the defect responsible for observed annealing, and (4) to investigate the possibility of dislocation pipe diffusion. Apparatus is described which is capable of continuously measuring changes in the elastic modulus and internal friction during gamma irradiation over the temperature range from less than 4°K to well above room temperature. A novel hollow-cylinder sample geometry permits use of a source strength of only 1 Ci. Survey experiments over a wide temperature range and isothermal irradiations above room temperature are discussed. The results are explained in terms of the Koehler-Granato-Lucke vibrating string dislocation model and the Thompson-Buck-Huntington-Barnes defect-dislocation interaction model. (auth)

3630 TRAPPING AND REEMISSION OF HELIUM FROM ION BOMBARDED POLYCRYSTALLINE TUNGSTEN. Pierre, J.; Paulmier, D. (Ecole Nationale Superieure d'Electricite et de Mecanique de Nancy, 54 (France)). C. R. Hebd. Seances Acad. Sci., Ser. A, B; 280: No. 9, 275-278(3 Mar 1975). (In French)
Results give evidence of a high energy desorption peak, which exhibits a rapid growth when the quantity of helium, trapped in the tungsten at energies higher than 400 eV, is increased. The presence of this peak can be explained by the migration of vacancies containing helium atoms, leading to the formation of microbubbles of gas in the metal. (FR)

3631 BULK MODULUS OF MATERIALS CONTAINING GAS-FILLED VOIDS. Johnson, R. A. (Univ. of Virginia, Charlottesville). Radiat. Eff.; 25: No. 1, 45-48(1975).
Voids created during neutron irradiation lead to volume swelling and changes in the elastic properties of metals. Present theoretical treatments of the effect of voids on elastic constants do not consider the possible effect of gas pressure or surface stresses within the voids. These corrections have been determined for the change in bulk modulus. Although parameters required for numerical evaluation are not available for materials of technological interest (e.g. stainless steels), values for copper indicate that various correction terms tend to cancel. Thus, gas pressure should not be important in predicting elastic property changes caused by voids, and conversely, experiments involving elastic property measurements are impractical as a method to determine gas pressure within voids. (auth)

3632 ANOMALOUS MODULUS CHANGE IN γ-IRRADIATED COPPER SINGLE CRYSTALS. Okuda, S.; Mizubayashi, H. (Japan Atomic Energy Research Inst., Tokai). Radiat. Eff.; 25: No. 1, 57-59(1975).
An anomalous change in the modulus of elasticity of gamma irradiated copper in low frequency measurements (approx. 600 Hz) and the implication of this anomaly on dislocation motion in low frequency is discussed. (UK)

3633 ADDITIVITY OF DECHANNELING FROM LATTICE VIBRATIONS AND POINT DEFECTS. Swanson, M. L.; Howe, L. M.; Quenneville, A. F. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Radiat. Eff.; 25: No. 1, 61-63(1975).
A high-energy ion, directed near close-packed rows or planes of atoms in a single crystal, can be dechanneled by electronic collisions or by nuclear collisions with displaced atoms. Displacements in the form of thermal vibrations or radiation damage can cause large increases in dechanneling. This paper examines whether the dechanneling caused by thermal vibrations and that caused by displacements (in the form of radiation-induced point defects) are additive for an Al–0.8% Ag alloy. It is concluded that they are, in fact, additive. (UK)

3634 EFFECT OF ELECTRON IRRADIATION ON DIFFUSION IN GOLD–SILVER ALLOYS. Bystrov, L. N. (Inst. of Metallurgy, Moscow). Radiat. Eff.; 25: No. 1, 53-54(1975).
At the present moment there is no single point of view as to the type of defect migrating at temperatures around the end of annealing Stage I for radiation defects (substages I_D and I_E). A model has been proposed, according to which substages I_D and I_E correspond to one-dimensional migration of interstitials in crowdion configuration whereas the free migration of interstitials (dumb-bell configuration) occurs at annealing stage III. This paper examines whether the one-dimensional crowdion migration can indeed cause the decay of compositional modulations. (UK)

3635 CORRELATION BETWEEN BLISTER SKIN THICKNESS, THE MAXIMUM IN THE DAMAGE-ENERGY DISTRIBUTION, AND PROJECTED RANGES OF He^+ IONS IN METALS: Nb. Kaminsky, M.; Das, S.K.; Fenske, G. (Argonne National Laboratory, Argonne, Illinois 60439). Appl. Phys. Lett. 27: No. 10, 521-523 (15 Nov 1975).
The skin thicknesses of blisters formed on niobium by helium-ion irradiation at room temperature for energies from 100 to 1500 keV have been measured. The projected ranges of helium ions in Nb for this energy range were calculated using either Brice's formalism or the one given by Schiott. For the damage-energy distribution Brice's formalism was used. The measured skin-thickness values correlate more closely with the maxima in the projected-range probability distributions than with the maxima in the damage-energy distributions. The results are consistent with our model for blister formation and rupture proposed earlier. (auth)

3636 COMMENT ON "FREE MIGRATION OF INTERSTITIALS IN TUNGSTEN". Seidman, D.N.; Wilson, K.L.; Nielsen, C.H. (Department of Materials Science and Engineering and the Materials Science Center, Cornell University, Ithaca, New York 14853). Phys. Rev. Lett. 35: No. 15, 1041-1042 (13 Oct 1975).
We briefly summarize the results of an extensive series of recent field-ion microscope experiments on ion-irradiated (20- and 30-keV W^+) tungsten (with residual resistance ratios varying from 5×10^4 to 5), tungsten specifically doped with carbon, and tungsten–0.5-at.% and –3-at.%-rhenium alloys. The field-ion microscope experiments are all consistent with the long-range migration of a self-interstitial atom occurring at ~ 38 K. This result is contrasted to the recent conclusions of Okuda and Mizubayashi. (auth)

3637 REPLY TO "COMMENT ON 'FREE MIGRATION OF INTERSTITIALS IN TUNGSTEN' ". Okuda, S.; Mizubayashi, H. (Japan Atomic Energy Research Institute, Tokai-mura, Ibaraki, Japan). Phys. Rev. Lett. 35: No. 15, 1043-1044 (13 Oct 1975).
The argument by Seidman, Wilson, and Nielsen concerning our recent Letter is shown to be not decisive. We now propose that the defects

associated with the 27-K internal-friction peak, in neutron-irradiated W may be di-interstitials. (auth)

3638 REPORT TO THE AMERICAN PHYSICAL SOCIETY BY THE STUDY GROUP ON PHYSICS PROBLEMS RELATING TO ENERGY TECHNOLOGIES: RADIATION EFFECTS ON MATERIALS. Vook, F.L. (Sandia Laboratories, Albuquerque, New Mexico 87115); Birnbaum, H.K.; Blewitt, T.H.; Brown, W.L.; Corbett, J.W.; Crawford, J.H. Jr.; Goland, A.N.; Kulcinski, G.L.; Robinson, M.T.; Seidman, D.N.; Young, F.W. Jr.; Bardeen, J.; Balluffi, R.W.; Koehler, J.S.; Vineyard, G.H. Rev. Mod. Phys. 47: S1-S44 (2 Oct 1975).

An APS sponsored study reviewed the state of research and development in radiation effects on materials for the purpose of identifying basic scientific problems which limit progress in energy applications and which could be attacked by physicists, especially those in universities. The field of radiation effects on materials has particular application throughout fission and fusion reactor technology, and the technological problems associated with these reactors were reviewed. Important scientific problem areas discussed included mechanical properties, point defects, voids and dislocations, theory of damage production, charged particle simulation of neutron damage, hydrogen and helium in materials, interaction of surfaces and radiation, insulators, semiconductors, and superconductivity. Although limited progress has been made on many of the scientific problems previously identified, the current energy crisis has greatly increased the economic urgency of improved understanding. In addition to many detailed suggestions, the study recommended increased effort on the following most important problem areas: A firm experimental and theoretical base for ion and electron simulation of neutron damage should be established. Increased emphasis should be placed on understanding the effects of impurities on the production, migration, and agglomeration of radiation produced defects, particularly the nucleation and growth of voids and dislocation loops. The experimental and theoretical understanding of mechanical properties as they are affected by point defects and their agglomerates, impurities, and defect-impurity combinations should be established. Experimental and theoretical understanding should be established for the dynamic effects of high flux irradiations such as enhanced diffusion, creep, precipitation, and re-solution. To aid the application of basic science to technology, increased university and laboratory cooperation was recommended. (auth)

3639 TEMPERATURE DEPENDENCE OF MAGNETIC ANISOTROPY INDUCED BY NEUTRON IRRADIATION IN Ni ALLOYS. Allia, P.; Soardo, G. P. (CNR, Turin). AIP (Am. Inst. Phys.) Conf. Proc.; No. 24, 735-736(1975).

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974). See CONF-741202-.

It has been shown that only in some Fe alloys the temperature dependence of induced anisotropy energy K/sub u/ due to directional order of solute pairs fits the third power law of saturation magnetization I/sub s/(T) derived from theories of crystalline anisotropy energy. In order to further investigate the role of various solute atoms, comparison with the case of Ni alloys is of interest, since, differently from Fe case, the rate of decrease of I/sub s/ and of Curie temperature T/sub c/ with concentration is proportional to the solute valency. In this work, K/sub u/ vs T data are reported for NiCr 5 percent and NiPd 43 percent. Since T/sub c/'s are too low to permit atomic diffusion in the presence of a nonzero I/sub s/, directional order was obtained by fast neutron irradiation (1,3 10^{18} n/cm^2) under magnetic field (approximately 5000 Oe) at about 60°C. K/sub u/ measurements were performed by means of a sensitive torque balance between about 100 and 320°K. From the present preliminary results, it is found that both in NiCr and in NiPd the K/sub u/ curves decay with increasing temperature faster than I^3/sub s/(T), approximately according to a I^6/sub s/(T) law, independently of the solute atom valency, which is 0 for Pd and 5 for Cr. (auth)

3640 MICROYIELDING AND EFFECT OF ELECTRON IRRADIATION IN HIGH-PURITY IRON SINGLE CRYSTALS. Sato, A.; Meshii, M. (Northwestern Univ., Evanston, IL). Phys. Status Solidi (a); 28: No. 2, 561-569(16 Apr 1975).

The effect of electron irradiation on the microyield stress was investigated in ZrH_2 purified Battelle-AISI iron single crystals at 4.2, 30, and 60°K. The irradiation caused a hardening effect which increased with the electron dose. This hardening effect in the microyielding is opposite to the observed softening effect in the macroyielding. These observations can be satisfactorily explained by the interaction of the irradiation-induced interstitials with edge and screw dislocations, respectively. The present observation is also regarded as strong evidence supporting the theory of an intrinsic mechanism for the low temperature strength and the solid solution softening in iron. (auth)

Other Materials

Refer also to abstracts 2653-2659, 2661-2663, 3442, 3477, 3489, 3562, 3638, 3946, and 4280.

3641 (ANL-Trans-1003) USE OF ELASTOMERS IN NUCLEAR REACTORS. Eude, J. C. Translated from Rev. Gen. Caoutch. Plast.; 49: No. 5, 395-401(1972). 12p. Dep. NTIS $4.50.

The principal applications of elastomers in the nuclear reactor domain are: sealing joints, valve flaps, points and coatings, and thermal and electrical insulators. Elastomers having special properties are required for certain applications: applications in the presence of radiations; use in contact with special fluids, e.g., CO_2(EL-4), liquefied Na of Phenix, or demineralized water. Some examples of problems encountered by the CEA are cited: joints of the Phenix plug and the EL-4 plug and incidents that have occurred with the valve flaps in EL-4. (FR)

3642 (GERHTR-134) METHODS FOR THE CHARACTERIZATION OF PYROLYTIC DEPOSITED CARBON. Bongartz, K.; Hoven, H.; Koizlik, K. (Kernforschungsanlage Juelich G. m. b. H. (F. R. Germany). Inst. fuer Reaktorwerkstoffe und Heisse Zellen). Jun 1974. Translation of JUL-1078-RW. 48p. Dep. NTIS $5.50.

Work performed under United States-German High Temperature Reactor Research Exchange Program.

Pyrocarbon is deposited as a coating material on fuel kernels used in HTGRs. For the development of particle coatings specified for various reactor designs, it is necessary to know the properties of pyrocarbon and their changes by neutron irradiation. In this report, procedures are described which are used to characterize pyrocarbon: measurement of geometry, density, microporosity, apparent crystallite size, anisotropy of orientation, modulus of elasticity, and strength of coatings, as well as ceramography, etching by oxidation, secondary and transmission electron microscopy. (auth)

3643 (ORNL-5050, pp 93-95) DIFFUSION OF ADSORBED SPECIES IN POROUS MEDIA. Oct 1975.

In Chemical Technology Division annual progress report for period ending March 31, 1975. (Oak Ridge National Lab., Tenn. (USA)).

Results of research on cesium transport in graphite at 600 to 1000°C are reported. Data on cesium penetration in nuclear grade graphites are presented graphically and analyzed. (JRD)

3644 (RT/PROT-(75)9) IMMOBILIZATION OF RADIOACTIVE WASTES IN CONCRETE IMPREGNATED WITH POLYMERS. Preliminary Study. Donato, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). May 1975. 35p. (In Italian). Dep. NTIS (US Sales Only) $4.50.

Polymer impregnated concrete has been examined from a technical point of view, as a possible medium for radioactive wastes immobilization. The dehydration and impregnation kinetics of concrete samples containing chemical sludges have been studied. Samples of concrete impregnated with styrene or methylmethacrylate, polymerized either with gamma radiations or with chemical catalysts, have been prepared. The compressive strength of impregnated concrete appears notably improved in comparison with that of control samples (plus 174%). The leachability, determined at 95°C for 24 h with cesium 137, decreases from 13.2 to 1.1%. (auth)

3645 NEW SEMICONDUCTING MATERIALS. Nikolic, P. M. (Univ., Belgrade). Sci. Sintering; 7: No. 2, 129-146(May 1975).

Properties of newly developed semiconducting materials are discussed. Information is included on In compounds and alloys, B compounds, Pb alloys, magnetic semiconductors, ternary chalcogenides, nonlinear optical materials, and layer compounds. (JRD)

3646 SINTERED MATERIALS FOR ELECTRICAL CONTACTS IN POWER ENGINEERING AND THEIR PROPERTIES. Schreiner, H. Sci. Sintering; 7: No. 2, 161-168(May 1975).

Properties of sintered materials used in power engineering electrical contacts are reviewed. Information and data are included on metal-metal composite materials, nonmetal-metal-metalloid systems, and contact properties. (JRD)

3647 EPR SPECTRA OF COLOUR CENTRES IN X-IRRADIATED $BaCl_2:K^+$ AND $BaCl_2:Ag^+$. Houlier, B. (Paris Univ., Orsay, France). Solid state Commun.; 17: No. 3, 263-266(1 Aug 1975).

X-irradiation at 80°K leads to the formation of V_K centers and, in addition, perturbed F centers in the case of $BaCl_2:K^+$. The V_K centers spectra exhibit a superhyperfine structure. A warming to 130°K of crystals x-irradiated at 80°K causes the V_K centers

to be perturbed, and besides leads to the formation of $(AgCl_4)^{2-}$ complexes in $BaCl_2:Ag^+$. (auth)

3648 INVESTIGATION OF RADIATION DAMAGE IN SILICON BY A BACKSCATTERING METHOD. Goetz, G.; Hehl, K.; Schwabe, F.; Glaser, E. (Friedrich-Schiller-Universitaet, Jena, Ger.). Radiat. Eff.; 25: No. 1, 27-32(1975).

The dose dependence of lattice disorder produced by implanted 200-keV argon ions was investigated for doses between $2 \times 10^{13}/cm^2$ and $1 \times 10^{17}/cm^2$ and four implantation temperatures, –196°C, 20°C, 200°C, and 400°C. Radiation damage was determined by means of the channelling technique with 1.4-MeV He^+-ions. To obtain the number of displaced Si atoms, the rise of the aligned energy spectrum in an energy region corresponding to the depth behind the disordered layer was measured. In this case it is possible to describe the disordered region as an amorphous surface layer leading to multiple scattering of the beam. The accuracy of a well-known thickness and maximal deviations of no more than 10% were obtained. Results for the total number N_T of disordered Si atoms show for lower doses a more than proportional increase with the dose N_I and for higher doses the well-known saturation effects connected with the complete amorphization of the surface layer. (auth)

3649 COMPARISON OF THE RADIATION DAMAGE PRODUCED IN GALLIUM ARSENIDE BY MONATOMIC AND DIATOMIC ARSENIC IMPLANTS. Moore, J. A. (Brock Univ., St. Catherine, Ont.); Carter, G.; Tinsley, A. W. Radiat. Eff.; 25: No. 1, 49-51 (1975).

20-keV monatomic and 40-keV diatomic As ions were implanted into GaAs at room temperature and the resultant radiation damage measured by means of the channeling and backscattering of 1-MeV He^+ ions. The energy density within each diatomic cascade is approximately twice the density within the monatomic cascade. The radiation damage resulting from the diatomic implant is observed to be significantly larger (two to three times) than from the monatomic implants. This observation shows, quite directly, that when significant annealing of damage is occurring during implantation one cannot adequately describe the damage production in terms of quantities averaged over the implanted layer; account must be taken of the character (e.g., energy density) of the individual damage cascades. (auth)

3650 SIMULATION OF AMORPHIZATION IN SILICON LATTICE. Knyzhnikov, Y. N. (Inst. of Atomic Energy, Moscow). Radiat. Eff.; 25: No. 1, 41-44(1975).

The process of disordering of structure of silicon crystallite being initially diamond-like was studied with the method of computer simulation under the action of the thermal excitation, which can be developed at the radiation damage as well. The central potential of interatomic interaction extended to two coordination spheres was used. Simulation results are compared with experimental results of the study of structure of silicon amorphous films with the electron diffraction method. (auth)

3651 EFFECT OF DUAL IMPLANTS INTO GaAs. Ambridge, T. (Post Office Research Dept., London); Heckingbottom, R.; Bell, E. C.; Sealy, B. J.; Stephens, K. G.; Surridge, R. K. Electron. Lett.; 11: No. 15, 314-315(24 Jul 1975).

Enhanced donor activities were obtained after annealing at 700°C for selenium implants into GaAs by implanting an equal dose of gallium together with the selenium. Donor concentration depth profiles, measured for both single and dual implants of $1 \times 10^{13}/cm^2$ and $2 \times 10^{14}/cm^2$ indicated that the increase in activity was mainly due to an increase in peak donor concentration for the dual implants compared with those measured for single implants. (auth)

3652 ENCAPSULATION OF ION-IMPLANTED GaAs USING NATIVE OXIDES. Sealy, B. J.; D'Cruz, A. D. E. (Surrey Univ., Guildford, Eng.). Electron. Lett.; 11: No. 15, 323-324(24 Jul 1975).

It was found that oxidation at 500 to 600°C produced uniform layers, which, when used as protective coatings for ion-implanted GaAs, gave rise to donor activity, but with poor reproducibility. The addition of a thin layer of evaporated aluminium to the oxide layer gave donor activities very similar to results obtained with other coating materials and with good reproducibility. (auth)

3653 CRYSTAL IMPERFECTIONS IN SILICON EPITAXIAL LAYERS GROWN ON ION-IMPLANTED SUBSTRATES. Baker, J. R. C.; Ogden, R. (Plessey Co. Ltd., Towcester, Eng.). J. Mater. Sci.; 10: No. 7, 1259-1261(Jul 1975).

Moline et al., (J. Electrochem. Soc.; 121:1362(1974)) have observed that crystal defects can be generated in an epitaxial layer grown on an ion-implanted substrate. They grew epitaxial layers by silane pyrolysis on substrates implanted with arsenic ions at 150 kV. In the present work, a similar experimental system was investigated and the same imperfect growth was found. Further, transmission electron microscopy was used to identify the defects present as edge dislocations and epitaxial stacking faults. Experimental details are presented and the results discussed. (UK)

3654 THERMAL CONDUCTIVITY OF PRASEODYMIUM TRIFLUORIDE AT HIGH TEMPERATURES. Remizova, L.A. (State Research Institute for Rare Metals). High Temp. 13: No. 1, 187-190 (Sept 1975).

The thermal conductivity of a single crystal of PrF_3, having high transparency in the infrared region of the spectrum [1,2], was measured by the relative method of a steady-state longitudinal heat flux (Fig. 1). The samples for the investigation were cut from the middle part of crystals grown by the Stokbarger–Stepanov method; the purity of the crystal obtained was not monitored; the degree of purity of the charge was 99.99%. To decrease the oxygen content in the charge of PrF_3, an additive of PbF_3 in the amount of 5 wt.% was introduced into the charge before the growing process. The thermal conductivity was measured along the axis of growth of the crystal. All the investigations were carried out in a vacuum with a residual pressure not exceeding 0.133 N/m^2 at $T < 800°K$ and 0.0133 N/m^2 with $T > 800°K$. (auth)

3655 INFLUENCE OF NEAR-SURFACE LAYER ON THE ANOMALIES IN THE SPECTRUM OF EXCITON REFLECTION OF CdS SINGLE CRYSTALS AT $T=4.2$ °K. Benémanskaya, G.V.; Novikov, B.V.; Cherednichenko, A.E. (Leningrad State University). JETP Lett. 21: No. 11, 307-308 (5 June 1975).

It was observed that the exciton-reflection spectra can be reversibly altered by irradiating CdS single crystals with low-energy electrons. Depending on the radiation dose, an exciton-free ("dead") layer of different depth is produced at the surface of the crystal, and this makes it possible to obtain quite definite curves of reflection spectra with different anomalies. (auth)

3656 PHYSICS OF IV-VI COMPOUNDS AND ALLOYS. Conference held at the University of Pennsylvania, Philadelphia, 24–25 March 1972. Rabii, S. (ed.). New York; Gordon and Breach Science Publishers (1974). 258p. (CONF-720359–).

Thirty-eight papers are presented under the following section headings: transport properties and applications, bond structure and lattice dynamics, physical properties and imperfections, and optical and magneto-optical properties. All the papers were published earlier in Journal of Nonmetals (Vols. 1 and 2). A summary of the conference is also included. (DLC)

3657 INVESTIGATION OF THE PHOTOPLASTIC EFFECT IN γ-IRRADIATED NaCl CRYSTALS. Ermakov, G. A.; Korovkin, E. V.; Soifer, Ya. M. (Inst. of Solid State Physics, Moscow). Sov. Phys.-Solid State; 16: No. 6, 1139-1141(Dec 1974).

Translated from Fiz. Tverd. Tela; 16: No. 6, 1756-1760(Jun 1974).

The photoplastic effect has been investigated on NaCl single crystals, irradiated up to a dose of 5×10^6 rad by a ^{60}Co source, using the viscosity method. The dislocation absorption of longitudinal ultrasonic waves has been measured by the pulse-echo method at 50 MHz in the temperature range 293 to 173°K. Switching on light leads to a reversible decrease in absorption of ultrasound α by a value $\Delta\alpha$. The spectral characteristics $\Delta\alpha(\lambda)$ agree with the absorption spectrum of F centers ($\lambda_{max} = 470$ nm). The transient characteristics $\Delta\alpha$ (when the light is switched on and off) have different forms for different light intensities I (for $I \geq 0.30$ I_M there is a fall in the plane peak of the pulse, $I_M \simeq 2 \cdot 10^{14}$ photons). The value of $\Delta\alpha$ increases with increasing light intensity I as $I^{\frac{1}{4}}$. The lengths of the leading and trailing edges decrease with increasing deformation velocity $\dot{\varepsilon}$. In order to explain the experimental data a model is proposed based on the fact that the binding points are F' and α centers, which appear on the dislocation line when the crystal is illuminated by light. This leads to a decrease in the length of the dislocation segments and, hence, to a decrease in the ultrasonic absorption. (auth)

3658 MICROSTRUCTURAL OBSERVATION OF GRAPHITE MATERIALS. Kimura, S. (Tokyo Inst. of Tech. (Japan). Research Lab. of Engineering Materials). Tanso; No. 78, 95-104 (Jul 1974). (In Japanese).

Optical microscopic and electron microscopic observation of the structure of graphite materials are reviewed according to the papers presented in the last several years. The review is classified into seven items, namely, (1) stream structure, (2) mesophase, (3) polycrystalline graphite materials, (4) influence of hot press, (5) pyrolytic carbon, (6) glassy carbon, and (7) composite of carbon fiber and carbonaceous materials. The cokes obtained from coal pitch and petroleum heavy oil by heating over 1,000°C often show streamline arrangement of graphite crystal plates with accompanying cracks. These cracks reduce thermal expansion coefficient and improve thermal shock resistance. The graphite materials for nuclear reactors have been precisely

investigated. The anisotropic materials of needle cokes, isotropic gilsonite cokes, and other cokes are illustrated. The change in microstructure under hot press is reviewed. Graphite particles come close to theoretical density even without binder under the pressurization of 1 ton/cm^2 at 2,200°C in helium. The hot pressed graphites using glassy carbon and Thornel fiber are illustrated. The microstructure of pyrolytic carbon has been observed, with an electron microscope. The pyrolytic carbon obtained from methane or propane in a fluidized bed is the same as that obtained in a fixed bed. (JA)

3659 BEHAVIOR OF ^{14}C-LABELED POLYMERIC 2-METHYL-5-VINYL-N-ALLYLPYRIDINIUM BROMIDE IN THE NICKEL PLATING SOLUTION. Adsorption on or Incorporation in the Nickel Plate. Nakabayashi, T.; Hamada, M. (Radiation Center of Osaka Prefecture, Sakai (Japan)); Arisato, Y. Radioisotopes (Tokyo); 24: No. 2, 83-87(Feb 1975).

In order to examine the behavior of polymeric pyridinium salts as effective corrosion-resistant reagents in nickel-plating, ^{14}C-labeled polymeric 2-methyl-5-vinyl-N-allylpyridinium bromide was prepared. The amount of the polymer that was incorporated in nickel, electrodeposited from a nickel plating solution, was determined by measuring its radioactivity. The polymer was undoubtedly incorporated in the nickel electrodeposit, and that the amounts of its incorporation were dependent on both current density and concentration of the polymer in the plating solution. The amount of the polymer adsorbed on the same nickel plate simply immersed in the plating solution was very small compared with that incorporated. (auth)

3660 RADIATION RESISTANCE OF PISTON RINGS MADE OF TEFLON FOR WASTE GAS COMPRESSORS. Muramatsu, T. (Ebara Mfg. Co. Ltd., Tokyo (Japan)). FAPIG (Tokyo); No. 74, 23-29(Sep 1974). (In Japanese).

The effects of gamma rays on carbon-impregnated teflon piston rings of a compressor for the argon waste gas of the fast test reactor "Joyo" are reported. This test was made under the consignment by Power Reactor and Nuclear Fuel Development Corporation from November 1971 to July 1972. The teflon contains 25% of tar pitch carbon below 250 mesh and is exposed to radiation in the course of waste gas compression. Radiation dose of about 10^6 rad during 6 months was used in this test. Under these conditions, behavior and endurance tests were performed. Separately, test pieces with various carbon content were tested with various radiation doses for comparison. Tension test, Rockwell hardness and impact bending tests, thermal expansion, abrasion test and endurance test were performed. Experiments revealed that this piston ring material can be employed perfectly in the range of not more than 10^6 rad, and it can endure to the extent of 40,000 hours, if mechanical deterioration is not taken into consideration. It is expected that this material can be employed in the compression storage treatment of rare gas in fuel reprocessing plants generating high radioactive off-gases. The tested material still has some reserve strength. Further development applicable to over 10^6 rad may be desired. (JA)

3661 METHOD OF MAKING EXPANDED PLASTICS HEAT RESISTANT. Kagiya, T.; Mitsui, H.; Hosoi, F.; Fujimoto, T.; Takada, H. (to Japan Atomic Energy Research Inst., Tokyo). Japanese Patent 1974-28902/B/. 22 Aug 1970. 5p. (In Japanese).

The heat resistance of expanded plastics of degradation-type, high-molecular monomers of vinyl polymers are improved in their cross-linking polymerization by irradiating with ionizing radiations in the presence of gaseous phase acetylene or allene compounds acting as chain cross-linking agents. This agent may be acetylene compounds containing at least one ethyl radical in one molecule, allene compounds containing at least one 1,2 dien construction, and compounds simultaneously containing the ethyl radicals and 1,2 dien construction in the same molecule. The vinyl monomers may be polymerizable compounds having at least one double bond C=C in one molecule as olefines, vinyl acetylene and its derivatives. The chain cross-linking agents are simple substances or mixtures of gaseous phase. Even 1 ppM addition quantity of the agents can improve the quality of the expanded plastics, the quantity being generally 10 ppM or 50% by weight. The concentration of the cross-linking agents are generally 10^{-6}–99 mol %, preferably 10^{-4}–90 mol %. In one example, a market available expanded plastic sheet was irradiated with ^{60}Co gamma-radiations of 4.8×10^5 r at room temperature in the presence of a mixed gas containing nitrogen, acetylene and acetylene tetrafluoroethylene (1:1). After irradiation, the sheet was heated at a rate of 2°C/min in an oven at 100°C for 15 minutes. (JA)

3662 COATING MATERIAL COMPOSITION. Ozeki, T.; Kimura, T.; Kobayashi, J.; Maeda, Y.; Nakamoto, H. (to Mitsubishi Rayon Co. Ltd., Tokyo (Japan)). Japanese Patent 1974-15617/B/. 8 Dec 1969. 9p. (In Japanese).

A polyester composition is provided for forming a hard, tough and weather-proof coating easily hardened by irradiation with an active energy, particularly electron beams, using a telomerized acrylic unsaturated polyester obtained by utilizing a methacrylic acid dimer or its dimethyl ester as an unsaturated dibasic acid component. A nonsolvent type coating material composition contains 10-100 parts of telomerized diacryl polyester. In one example, a methacrylic acid-telomerized polyester containing a methacrylic dimer was produced from 2.2 mol of methacrylic acid, 1 mol of methacrylic acid dimer, 2 mol of ethylene glycol, 2 g of hydroquinone monomethyl ether, 12 g of p-toluene sulfonic acid and 500 ml of toluene. The product was applied to a plywood and irradiated with 0.5-MeV electron beams. (JA)

3663 VLIYANIE RADIATSIONNYKH DEFEKTOV NA LYUMINESTSENTSIYU MONOKRISTALLA NaCl–Eu PRI KANALIROVANII α-CHASTITS S ENERGIEY 60 keV. (Effect of Radiation Defects on Luminescence of the Monocrystal NaCl–Eu when 60 keV α-Particles Are Channeled). Alekse'ev, V. I.; Bazhin, A. I.; Konopel'ko, E. I.; Kukhtin, V. V. Moscow; All-Union Inst. of Scientific and Technical Information (1937). 10p.

The monocrystals NaCl-Eu with an activator concentration of 10^{-3} atomic percent were bombarded with 60 keV α-particles and current density $j = 0.007$ μA/cm^2. A 3-mm diameter ion beam with an angular spread of 0.2° was directed along the axes ⟨100⟩ of the crystal. When the angle between the α-particle beam and the axes ⟨100⟩ was varied, an abrupt maximum of the luminescence intensity was observed with an angular half-width of 3.6° and a relative peak of 1.5. The growth kinetics of the most massive defects formed upon irradiation on the f-centers was investigated. The density of defects in the case of channelized particles for the same radiation doses is lower than for a random beam. Formation of Frenkel pairs and also the growth in the concentration of interstitial atoms with increase in radiation dose promote plugging of the open channels and equalizing of the relative intensities of luminescence for the channelized and the random beams. At high radiation densities ($j > 0.1$ μA/cm^2), the surface begins to be amorphized and the luminescence practically disappears. (Ref. Zh.)

3664 CHARGE CARRIER RELEASE IN He-COOLED CRYSTALS BY PHONON FLUXES GENERATED BY IMPINGING HOT GAS ATOMS, BY HEAT PULSES, OR BY α-PARTICLES. Riehl, N.; Wengert, R. (Technische Univ., Munich). Phys. Status Solidi (a); 28: No. 2, 503-509(16 Apr 1975).

Phonon fluxes generated in different He-cooled crystals of ZnO (luminescent), B, Si, Al_2O_3, quartz, Ge, and NaCl by bombardment of the crystal surface with hot gas atoms or by short heat pulses or by alpha particles are investigated by using trapped (weakly bounded) charge carriers as detectors for high-frequency phonons. The energy depth E_t up to which traps are emptied by the phonons is compared with the maximal LA-phonon energy E_{ph} of the given crystal. This comparison allows to conclude whether the emptying is due to single phonons or to multiphonon processes and how the probability of multiphonon processes depends on the method of phonon generation. If the phonon flux is produced by gas bombardment the trap emptying is due only to the action of single phonons. Multiphonon processes (emptying of deeper traps) occur in the much more dense phonon fluxes generated by short heat pulses. The highest probability for multiphonon effects is found for phonon fluxes generated by alpha particles because of the extreme high density of a phonon pulse produced by an α particle. Conclusions about passing of high-frequency phonons through boundaries without degradation are possible, too. (auth)

3665 DEFECT CENTERS IN SILICON PRODUCED BY ROOM TEMPERATURE ELECTRON IRRADIATION. I. Optical and Photoconductivity Studies. Natarajan, K.; Heasell, E. L. (Univ. of Waterloo, Ont.). Phys. Status Solidi (a); 28: No. 2, 603-608 (16 Apr 1975).

Results of photoconductivity measurements on high-resistivity, oxygen-free, electron-irradiated silicon are presented. Narrow peaks, seen in photoconductivity, are shown to arise from local excitations of the defects produced. It is shown that the dominant defects produced are the divacancy and a second type of defect, possibly the K center. Results support the view of a charge state-dependent lattice distortion near the defects. The defect lattice interaction energy is estimated to be ≈60 meV. (auth)

3666 ANNEALING STAGE OF ELECTRON RADIATION DAMAGES IN IN-DOPED n-TYPE CdTe CRYSTALS. Matsuura, K.; Tsurumi, I. (Tottori Univ., Koyama, Japan). Phys. Status Solidi (a); 28: No. 2, K175-K178(16 Apr 1975).

Electrical properties and annealing behavior were studied in In-doped CdTe crystals irradiated with 1.5-MeV electrons at room temperature. The conductivity decreases with irradiation; the decrease is annealed at temperatures above 170°C. (DLC)

3667 ANISOTROPY OF THE PROTON SPIN–LATTICE RELAXATION TIME IN THE SUPERCONDUCTING INTERCALATION COMPLEX $TaS_2(NH_3)$: STRUCTURAL AND BONDING IMPLICATIONS. Gamble, F.R.; Silbernagel, B.G. (Corporate Research Laboratories, Exxon Research and Engineering Company, Linden, New Jersey 07036). J. Chem. Phys. 63: No. 6, 2544-2552 (15 Sept 1975).

The nature of the interaction responsible for the formation of molecular intercalation complexes between Lewis bases and layered transition metal dichalcogenides is not well understood. To some extent this is due to a lack of structural information. A prototype of these complexes is $TaS_2(NH_3)$, in which monolayers of ammonia are inserted between the metallic, superconducting layers of TaS_2. The compound is crystalline and stoichiometric. Measurement of the anisotropy of the proton spin–lattice relaxation time at 300°K indicates that the molecular threefold symmetry axis is not perpendicular to the disulfide layers as suggested by other workers, but is parallel to the layers. This orientation precludes *direct* interaction between the molecular lone pair orbital and the transition metal atoms. The interactions governing the structure of this complex may be similar to those obtaining in the intercalation complexes between TaS_2 and a number of substituted pyridines, in which complexes the axis of the lone pair orbital is also parallel to the layers. (auth)

3668 LOW-TEMPERATURE ELASTIC CONSTANTS OF A SUPERCONDUCTING COIL COMPOSITE. Weston, W.F. (Cryogenics Division, Institute for Basic Standards, National Bureau of Standards, Boulder, Colorado 80302). J. Appl. Phys. 46: No. 10, 4458-4465 (Oct 1975).

A resonant piezoelectric oscillator method for measuring elastic moduli was applied to composite materials. The complete set of elastic compliances of a superconducting coil composite was determined semicontinuously between 4 and 300 K. Also, two moduli of a layered fiber-glass–epoxy composite were determined; this composite is essentially the matrix material of the coil composite. The Young's moduli, shear moduli, Poisson ratios, and elastic stiffness coefficients are also reported. Results agree closely with elastic data obtained by conventional testing methods. (auth)

3669 TERTIARY DEFECTS IN PHOSPHORUS-IMPLANTED SILICON. Tamura, M.; Yoshihiro, N.; Ikeda, T. (Central Research Laboratory, Hitachi Ltd., Kokubunji, Tokyo, Japan). Appl. Phys. Lett. 27: No. 8, 427-429 (15 Oct 1975).

Transmission electron microscopic observations have been made on dislocations generated in high-dose (1×10^{15}–3×10^{16} ions/cm^2) phosphorus-implanted (111) silicon wafers followed by 1100°C isothermal annealing in inert (dry N_2) and oxidizing (wet O_2) atmospheres. The generation and movement of dislocations in a wafer are strongly influenced by atmospheres during annealing. In dry-N_2 annealing, the critical ion dose for generation of dislocation networks is 1×10^{16} ions/cm^2, which is three times higher than that in wet-O_2 annealing. Also, dislocations move down to greater depths in a wafer after annealing in a wet-O_2 atmosphere, while in dry-N_2 annealing their location in a wafer is usually unchanged. (auth)

3670 RECOMBINATION OF CARRIERS IN n-TYPE InAs AT 77°K. Blaut-Blachev, A.N.; Balagurov, L.A.; Karataev, V.V.; Omel'yanovskii, E.M. (State Scientific-Research and Design Institute of Rare-Metallurgy Industry, Moscow). Sov. Phys.—Semicond. 9: No. 4, 515-516 (Apr 1975).

Using the photoconductivity and photomagnetic effect, the carrier lifetime in *n*-type InAs was measured and the result was compared to theoretical values. (AIP)

3671 ELECTROREFLECTION SPECTRA OF THE SURFACE OF ION-BOMBARDED SILICON. Gavrilenko, V.I.; Dubchak, A.P.; Zuev, V.A.; Litovchenko, V.G.; Lysenko, V.S. (Institute of Semiconductors, Academy of Sciences of the Ukrainian SSR, Kiev). Sov. Phys.—Semicond. 9: No. 4, 460-464 (Apr 1975).

The electroreflection spectra were determined for silicon surfaces subjected to etching and bombardment with argon and helium ions. The investigation was carried out in the photon energy range 3.0–5.0 eV at 300°K. The energy of the critical point E_1 (E_0) changed from 3.42 eV (for an etched surface) to 3.6 eV (for a surface bombarded with the maximum dose of $\sim10^{17}$ cm^{-2} argon ions). The energy of another critical point E_2 = 4.3 eV was found to be independent of the radiation dose D. Moreover, the broadening parameter Γ increased from 110 to 450 meV at the maximum dose and the amplitudes of the electroreflection peaks decreased; this was correlated with an increase in the density of the surface electron states. Possible causes of these bombardment-induced changes were considered. The appearance of heterogeneously distributed mechanical stresses and electric fields in the surface layer of silicon subjected to bombardment was identified as the dominant mechanism responsible for changes in the energy-band structure. (auth)

3672 INVERSION OF THE TYPE OF CONDUCTION AND STABILIZATION OF THE FERMI LEVEL IN IRRADIATED SILICON. Kuznetsov, V.I.; Logvinenko, T.A.; Lugakov, P.F.; Tkachev, V.D. (V. I. Lenin Belorussian State University, Minsk). Sov. Phys.—Semicond. 9: No. 4, 491-492 (Apr 1975).

The defects responsible for the inversion of the type of conduction and for the stabilization of the Fermi level in silicon were studied. The sample was irradiated with 10 MeV electrons and fast neutrons, and the annealing of the defects were investigated. (AIP)

3673 TECHNIQUES FOR PRODUCING HARD TUNGSTEN CARBIDE ALLOYS FOR MINING TOOLS. Mirchev, M. Tsvetn. Met.; 10: 73-80(1972). (In Bulgarian).

Methods of producing hard WC–Co alloys for mining purposes are described and discussed. The W is first produced in the form of a powder by the reduction of WO_3 and H_2WO_3 at 900°C; the powder has a specific surface area of 0.36 m^2/g and a pyknometric density of 18.95 g/cm^3. The powder is then carbided by bringing it into contact with graphite powder in a H atmosphere at 1700°C or a little above; the efficiency of the carbiding and the mechanical properties of the final alloy depend to some extent on the exact temperature as well as the quality of the powder. The alloy has a bend strength of 1900 MN/m^2 and a hardness of 88 HRA. (Metals Abstr.)

NUCLEAR MATERIALS AND WASTE MANAGEMENT

Accountability and Safeguards

3674 (AAEC/IP-4) CONDITIONS APPLYING TO AUSTRALIAN URANIUM EXPORTS: SAFEGUARDS OBLIGATIONS UNDER NPT. Rotsey, W. B. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Aug 1975. 17p. Dep. NTIS (US Sales Only) $4.00.

The Australian Government's expressed desire to inhibit the spread of nuclear weapons and its wish to prevent Australia's uranium exports being used for manufacture of nuclear explosives are underwritten by Australia's formal international obligations. Australia is not free to export its material without paying due regard to supra-national requirements. Two safeguards regimes, one applying to countries such as Australia which are party to the Treaty on Non-Proliferation of Nuclear Weapons (NPT), the other to those which are not parties are defined. The application of safeguards and the role of the International Atomic Energy Agency (IAEA) are briefly explained. Australia's obligations under the NPT and those stemming from specific undertakings to the IAEA are stated. The latter require Australia to ensure that Non-Nuclear Weapons States not party to the NPT give assurances that Australian uranium will not be used for the manufacture of nuclear explosives and that they will permit verification by the IAEA. These obligations give rise to a set of minimum conditions applying to exports of Australian uranium which vary according to the NPT status of the importing countries. (auth)

3675 (REG/G-5.44(1-75)) PERIMETER INTRUSION ALARM SYSTEMS. (USAEC Directorate of Regulatory Standards, Washington, D. C.). Jan 1975. 6p. NUREG.

The guide describes five types of perimeter intrusion alarm systems for fuel reprocessing plants and for plants at which enriched U, ^{233}U, or plutonium is used or processed. Criteria for the alarm systems use and performance are included. (JRD)

3676 (SAND-75-5351) ADVANCED PHYSICAL PROTECTION SYSTEMS FOR NUCLEAR MATERIALS. Jones, O. E. (Sandia Labs., Albuquerque, N. Mex. (USA)). Oct 1975. 21p. (CONF-751017-13). Dep. NTIS $4.50.

From symposium on safeguards of nuclear materials; Vienna, Austria (20 Oct 1975).

Because of the increasing incidence of terrorism, there is growing concern that nuclear materials and facilities need improved physical protection against theft, diversion, or sabotage. Physical protection systems for facilities or transportation which have balanced effectiveness include information systems, access denial systems, adequate and timely response, recovery capability, and use denial methods for despoiling special nuclear materials (SNM). The role of these elements in reducing societal risk is described; however, it is noted that, similar to nuclear war, the absolute risks of nuclear theft and sabotage are basically unquantifiable. Sandia Laboratories has a major US Energy Research and Development Administration (ERDA) role in developing advanced physical protection systems for improving the security of both SNM and facilities. These activities are surveyed. A computer simulation model is being developed to assess the cost-effectiveness of alternative physical protection systems under various levels of threat. Improved physical protection equipment such as perimeter and interior alarms, secure portals, and fixed and remotely-activated barriers is being developed and tested. In addition, complete prototype protection systems are being developed for representative nuclear facilities. An example is shown for a plutonium storage vault. The ERDA safe-secure transportation system for highway shipments of all significant quantities of government-owned SNM is described. Adversary simulation as a tool for testing and evaluating physical protection systems is discussed. A list of measures is given for assessing overall physical protection system performance. (auth)

3677 (UCRL-13638) QUANTITATIVE EVALUATION OF THE RETIMAC SYSTEM. Bain, E. E.; Fisher, R. H.; Gozani, T.; Harris, L. Jr.; Kendrick, H.; Kull, L. A.; Murri, E. L.; Ollivier, R. T.; Simmons, G. L. (Science Applications, Inc., La Jolla, Calif. (USA)). 10 Jun 1975. 180p. Dep. NTIS $8.50.

For Lawrence Livermore Lab., CA.

One means of raising the degree of protection afforded strategic special nuclear materials against theft and diversion is the installation of Real Time Material Control (RETIMAC) systems. The ability of RETIMAC to detect any covert attempt to steal special nuclear materials in a time frame that is adequate to contain subcritical quantities of special nuclear material within the boundaries of the material protection system and to maintain current knowledge of the quantity and location of all strategic special nuclear material was tested. A commercial-scale mixed oxide fuel fabrication plant was chosen for the study. (LK)

Disposal and Storage

Refer also to abstracts 2700, 2702, 2707, 2713, 2721, 3006, and 3644.

3678 (ARH-SA-221) CONCEPTUAL DESIGN CONSIDERATIONS FOR THE STORAGE OF SOLIDIFIED HIGH-LEVEL WASTE IN CANISTERS AT A COMMERCIAL FUEL REPROCESSING PLANT. LaRiviere, J. R.; Moore, E. L. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Nov 1975. Contract E(45-1)-2130. 19p. (CONF-751107-3). Dep. NTIS $4.00.

From 68th annual meeting of American Institute of Chemical Engineering; Los Angeles, California, USA (16 Nov 1975).

Onsite storage of canisters of solidified high-level waste generated by the commercial fuel reprocessing plants (FRP) may be required prior to shipping these canisters to a Federal repository. The most likely storage concept is to hold the waste-filled canisters in water storage basins. In the Retrievable Surface Storage Facility conceptual design studies, air-cooled and water-cooled storage of solidified high-level wastes has been considered. The studies of water-cooled storage included design considerations, as part of the conceptual design of the canisters and water storage basins, that would apply also to the conceptual design of similar facilities at an FRP. These similar considerations include: types of corrosion likely to develop on canisters stored in water, conditions that promote stress corrosion cracking (SCC), prevention of SCC, routine basin water cleanup, cleanup of a grossly contaminated water basin, effluent discharge discussions, storage basin integrity, and designing for decommissioning. (auth)

3679 (ARH-ST-110D) ATLANTIC RICHFIELD HANFORD COMPANY WASTE MANAGEMENT AND TRANSPORTATION TECHNOLOGY DEVELOPMENT. Quarterly Report, April 1975—June 1975. Lyon, R. Y. (ed.). (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Sep 1975. Contract E(45-1)-2130. 47p. Dep. NTIS $3.75.

The specific topics discussed are grouped into the subject areas of: (1) Storage System Integrity and Engineered Improvements, (2) Waste Retrieval, (3) Waste Immobilization and Storage, and (4) Contaminated Equipment Volume Reduction. (auth)

3680 (BNWL-B-430) POLYMERIC MEDIA FOR TRITIUM FIXATION. Franz, J. A.; Burger, L. L. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 15 May 1975. Contract E(45-1)-1830. 28p. Dep. NTIS $5.45.

The synthesis and leach testing of several polymeric media for tritium fixation are presented. Tritiated bakelite, poly(acrylonitrile) and polystyrene successfully fixed tritium. Tritium leach rates at the tracer level appear to be negligible. Advantages and disadvantages of the processes are discussed, and further bench-scale investigations underway are reported. Rough cost estimates are presented for the different media and are compared with alternate approaches such as deep-well injection and long-term tank storage. Polymeric media costs are high compared to deep-well storage and are of the same order of magnitude per liter of water as for isotopic enrichment. With this limitation, polymeric media can be economically feasible only for highly concentrated tritiated wastes. It is recommended that the bakelite and polystyrene processes be examined on a larger scale to permit more accurate cost analysis and process design. (auth)

3681 (ORNL-5050, pp 4-19) WASTE MANAGEMENT. Oct. 1975.

In Chemical Technology Division annual progress report for period ending March 31, 1975. (Oak Ridge National Lab., Tenn. (USA)).

Status of the following studies is reported: Geologic Disposal Evaluation Program; processing modifications for improved waste management; leaching of radionuclides from waste solids; methods for management of ORNL liquid wastes; and projections of radioactive wastes from the nuclear fuel cycle. (LK)

3682 (ORNL-5050, pp 96-100) MISCELLANEOUS PROGRAMS. Oct 1975.

In Chemical Technology Division annual progress report for period ending March 31, 1975. (Oak Ridge National Lab., Tenn. (USA)).

Miscellaneous programs reported included resource studies; studies involving tests of obsolete casks; disposal of ORNL radioactive waste by hydraulic fracturing; storage, purification, and

distribution of ^{233}U; chemical applications of nuclear explosives; preparation of training guides for nuclear facility personnel; and environmental impact statement on the U. S. nuclear power export program. (LK)

3683 CONCLUSIONS DRAWN FROM STUDIES ON THE OKLO NATURAL NUCLEAR REACTOR CONCERNING THE EVOLUTION IN THE GROUND OF RADIOACTIVE WASTE OVER A LONG PERIOD. Frejacques, C. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Div. de Chimie). pp 256-257 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French)

From 1st European nuclear conference; Paris, France (21 Apr 1975).

Study showed that the greater part of fission products, and in particular the rare earths and approximately all the plutonium formed, remained on the spot, a size of less than a few microns. (FR)

3684 RADIOLOGICAL PROBLEMS OF LIQUID WASTE DISPOSAL INTO THE SEA. Martin, J. J. (Electricite de France, 93 - Saint-Denis. Dept. de Radioprotection); Boissonet, B. (Electricite de France, 75 - Paris. Region d'Equipement). pp 165-167 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French)

From 1st European nuclear conference; Paris, France (21 Apr 1975).

A methodology where every external or internal irradiation aspect is explored and quantified, is presented. Study of these features includes the choice of parameters such as the dilution factor of the effluent in the sea or the consumption rate of edible sea organisms which may vary from one site to another. In a first approach, it is considered that the site is standard and doses through each exposure pathway are calculated with pessimistic assumptions for each parameter entering into the circulation. Pessimistic assumptions are chosen for French seashore sites but it is always possible to modify a parameter for a specific site when it is an evident fact. Three main population groups have been selected: the fishermen group, the nearest population group, and the summer visitors. For each of these groups a definite time of exposure and a definite daily intake of edible sea products have been assumed. (FR)

3685 PRESENT AND FUTURE IN THE MANAGEMENT OF RADIOACTIVE WASTES. Cousin, O. (CEA Direction des Productions, 92 - Chatillon (France)). pp 259-266 of 8th National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French)

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

The origins of wastes, their quantity, and present-day storage policy are reviewed. The quantities of wastes produced are estimated on the basis of certain criteria, which are listed and from which the following categories are defined: low and medium-activity wastes; high and very high-activity wastes; low-activity wastes containing α emitters. So far Infratome is the only centre created for final storage. Since the quantities should increase considerably, other final storage sites will be necessary in future. (FR)

3686 KAERNKRAFTENS HOEGKTIVA AVFALL. Laegesrapport Fraan Aka-Utredningen Den 24 Juni 1974. Industridepartementet Stencil Ds I 1974:6. (High Level Radioactive Wastes from Nuclear Power Stations. Progress Report from the Aka-investigation 24 June 1974. Ministry for Industry, Stencil Ds I 1974:6). Malmoe, Sweden; Industridepartementet (Jun 1974). 181p. (In Swedish).

The high level radioactive wastes from nuclear power stations have been investigated, in order to consider the establishment of new nuclear power stations in Sweden. The management of high level radioactive wastes and possibilities of reprocessing in Sweden is discussed. A survey is given of the biological radiation hazards in connection with reprocessing of nuclear fuel. Different possibilities of disposing of high level radioactive wastes from Swedish nuclear power stations are compared. Also geological aspects are considered in connection with long time disposal. (auth)

3687 APPARATUS FOR DISPOSING RADIOACTIVE WASTE SLUDGE. Kamiya, K.; Yusa, H.; Takejima, M. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1973-11280/B/. 9 Nov 1970. 3p. (In Japanese).

An apparatus for disposing radioactive waste sludge in water from a reactor is disclosed. The apparatus comprises a main tank having a sludge hardening agent charging inlet disposed at the lower portion, and a cartridge filtering tank having a filter therein which is detachably connected to the lowest end of the main tank. Water containing radioactive sludge is introduced from the main tank into the cartridge filtering tank where sludge is dehydrated. Residual dehydrated sludge is then hardened by the hardening agent. Pure water which is filtered through the filtering tank is pumped into a water reservoir for reutilization. The cartridge filtering tank may be disconnected from the main tank so that residual solidified sludge is disposed. The apparatus of the present invention does not require a high capacity water tank or centrifugal filter. (JA)

Handling Equipment and Procedures

3688 (CONF-751029-1) MASTER-SLAVE MANIPULATORS AND REMOTE MAINTENANCE AT THE OAK RIDGE NATIONAL LABORATORY. Jenness, R. G.; Wicker, C. D. (Oak Ridge National Lab., Tenn. (USA)). 1975. 9p. Dep. NTIS $4.00.

From National Bureau of Standards workshop; Annapolis, Maryland, USA (23 Oct 1975).

The volume of master-slave manipulator maintenance at Oak Ridge National Laboratory has necessitated the establishment of a repair facility and the organization of a specially trained group of craftsmen. Emphasis on cell containment requires the use of manipulator boots and the development of precise procedures for accomplishing the maintenance of 283 installed units. To provide the most economical type of preventive maintenance, a very satisfactory computer-programmed maintenance system has been established at the Laboratory. (auth)

Transportation

Refer also to abstracts 3682, 4844, and 4903.

3689 (SAND-75-5658) SPENT AND FRESH FUEL SHIPPING CASK CONSIDERATIONS. Shappert, L. B.; Unger, W. E.; Freedman, J. M. (Oak Ridge National Lab., Tenn. (USA); Sandia Labs., Albuquerque, N. Mex. (USA)). 1975. 18p. (CONF-751101-24). Dep. NTIS $4.50.

From joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

A program to provide basic information for cask design and safety has been conducted for over ten years at Oak Ridge National Laboratory. Principal problem areas in Liquid Metal Fast Breeder Reactor (LMFBR) casks are identified as heat transfer, structures and containment, criticality and shielding. Solutions in the problem areas, as well as the need for future work, are addressed by describing an LMFBR conceptual design cask. A new program, which is underway at Sandia Laboratories, Albuquerque, New Mexico, is aimed at producing technology useful to industry and government. Technologies are being developed in areas of hazards analysis, heat transfer, shielding, structures and containment, and spent fuel characterization, substantiated by hot laboratory verification. Particular emphasis will be placed on establishing qualification tests based on accident experience. Handling requirements and limitations are discussed. (auth)

PARTICLE ACCELERATORS

Design, Development, and Operation

Refer also to abstracts 2854, 2946, 3700, 4286, and 4290.

3690 (ANL-EC-3) GENERAL PURPOSE 1 GeV/c SEPARATED BEAM AT THE ARGONNE ZGS. Colton, E. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 40p. Dep. NTIS $5.00.

Design and operation of the low-momentum beam are discussed. In the normal operating mode, the beam acceptance is calculated to be 21 msr percent DELTA P/P at 1 GeV/c. At 0.8 GeV/c, enriched kaon fluxes of 2940 K^- or 16,390 K^+ are expected for 10^{11} 12.3 GeV/c incident protons, while 420 anti p are expected at 1 GeV/c. In the reversed-polarity operating mode, the maximum beam acceptance is calculated to be 15.2 msr percent DELTA P/P; excellent momentum resolution is available in pion and proton beams which are run in this mode. Results indicate that the beam operates as predicted, with the exception of separator rejection factors. (auth)

3691 (CONF-751115-1) FERMILAB TARGET AREAS AND TARGET TRAIN SYSTEMS. Lindberg, J.; Grimson, J.; Simon, J.; Theriot, D. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). Jul 1975. 26p. Dep. NTIS $4.50.

From 23rd conference on remote systems technology; San Francisco, California, USA (16 Nov 1975).

Proton beam-line equipment and shielding in the 400 GeV accelerator external target areas will become radioactive. Target handling systems, similar to trains, were designed and built to transport the radioactive equipment from the target areas to a central target service building for maintenance and repair. These radioactive tasks are carried out using servo manipulators. (auth)

3692 (COO-1805-2) ACQUISITION OF THE ANL 4-MeV ELECTROSTATIC ACCELERATOR. Progress Report, September 1, 1974–August 31, 1975. Dixon, D. R.; Hill, M. W. (Brigham Young Univ., Provo, Utah (USA)). 1975. Contract AT(11-1)-1805. 9p. Dep. NTIS $4.50.

The operation of the ANL 4-MeV accelerator for the reporting period September 1, 1974 through August 31, 1975 is described. Some improvements and modifications to the accelerator and associated equipment are reported, and activities on the three research projects are summarized. An outline of work for the next reporting period indicates a shift from the BYU 2-MeV accelerator to the 4-MeV accelerator to take advantage of the higher beam energy. (auth)

3693 (KFK-EXT-3/75-3) CONCEPT STUDY FOR SUPERCONDUCTING PROTON LINEAR ACCELERATOR. Citron, A.; Kuntze, M.; Bauer, W.; Graf, F.; Juengst, W.; Kluge, W.; Lehmann, H.; Mittag, K.; Schulze, D.; Zieher, K. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Experimentelle Kernphysik). Aug 1975. 40p. (In German) Dep. NTIS (US Sales Only) $5.00.

Radiation therapy of cancer presently uses primarily γ-rays or electrons. Theoretical studies prove that negative pions could destroy a tumor while causing much less damage to the healthy tissue than other kinds of radiation. To produce negative pions, proton or electron accelerators of both high energy and current are necessary. A study was made of a superconducting linear accelerator as a booster for the 100 μA proton beam of a 200 MeV isochronous cyclotron proposed elsewhere to deliver a final energy of 600 MeV. A possible set of parameters for the superconducting proton linear accelerator is discussed in detail, and a cost estimate is given. Although further studies are necessary, this superconducting version is attractive compared to normal conducting accelerators. (auth)

Ion Optics and Field Calculations

3694 (LA-6043-MS) CALCULATED NEUTRON SPECTRUM FROM 800-MeV PROTONS INCIDENT ON A COPPER BEAM STOP. Perry, D. G. (Los Alamos Scientific Lab., N. Mex. (USA)). Oct 1975. Contract W-7405-ENG-36. 14p. Dep. NTIS $4.00.

A Monte Carlo calculation was performed to obtain the neutron spectrum generated by 800-MeV protons incident on the LAMPF main copper beam stop. The total flux is calculated to be of the order of 10^{13} n/cm^2-sec-mA at full-beam intensity of 1 mA, with flux spectra calculated for angles of 20^0, 30^0, 60^0, 90^0, 120^0, and 150^0. (auth)

3695 (LA-tr--75-32) MUTUAL TRANSFORMATION OF LONGITUDINAL AND TRANSVERSE EMITTANCES OF ACCELERATED BEAMS. Murin, B. P.; Gromov, E. V.; Kushin, V.V. Translated from Tr. Radiotekh. Inst.; No. 16, 348-360(1974). 8p. Dep. NTIS $4.50.

An accelerated beam transformation permitting a reduction of either its longitudinal or transverse beam emittance was studied. The main requirement for the emittance reduction is the existence of short, well-focused bunches in the beam prior to transformation. The better the beam is focused, the higher is the degree of longitudinal emittance reduction; the better the particles are bunched in phase, the higher is the degree of transverse emittance reduction. As the hypervolume occupied by all the points representing the bunch in the six-dimensional space remains unchanged, each of the transformations under consideration is accompanied by an increase in the projections of this hypervolume onto the remaining phase space planes. (auth)

3696 (SAND-75-5746) IONIZATION FRONT ACCELERATOR. Olson, C. L. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1975. 29p. (CONF-751108-8). Dep. NTIS $4.50.

From 1st international topical conference on electron beam research and technology; Albuquerque, New Mexico, USA (3 Nov 1975).

In a recently proposed linear collective accelerator, ions are accelerated in a steep, moving potential well created at the head of an intense relativistic electron beam. The steepness of the potential well and its motion are controlled by the external ionization of a suitable background gas. Calculations concerning optimum choices for the background gas and the ionization method are presented; a two-step photoionization process employing Cs vapor is proposed. In this process, a super-radiant light source is used to excite the gas, and a UV laser is used to photoionize the excited state. The appropriate line widths and coupled ionization growth rate equations are discussed. Parameter estimates are given for a feasibility experiment, for a 1 GeV proton accelerator, and for a heavy ion accelerator (50 MeV/nucleon uranium). (auth)

3697 EFFECT OF POSITIVE IONS ON TRANSVERSE BEAM OSCILLATIONS IN A PROTON SYNCHROTRON. Balbekov, V.I. Sov. Phys.—Tech. Phys. 20: No. 2, 208-212 (Feb 1975).

The transverse oscillations of a circulating proton beam due to the interaction with positive ions are analyzed. These ions are produced by ionization of the residual gas by protons. The various instabilities are interpreted as betatron resonances caused by the ion field. A dispersion relation describing resonances of any type, including nonlinear and coupling resonances, is derived and solved. This equation can be used to analyze other instabilities, e.g., the wall instability. The first-order and second-order resonances, which drive oscillations of the center of gravity and of the transverse beam dimensions, are analyzed in detail. (auth)

3698 MAGNETIC-FIELD FORCING IN TANDEM ACCELERATION OF NUCLEI IN THE JINR FM CYCLOTRON. Kazanskii, G.S.; Mikhailov, A.I.; Smirnov, A.A. Sov. Phys.—Tech. Phys. 20: No. 2, 213-215 (Feb 1975).

Calculations are performed regarding the forcing of the magnetic field in the JINR FM cyclotron in order to improve the efficiency of the tandem synchrotron acceleration. Also considered are appropriate power supplies. (AIP)

Storage Rings

3699 IMPROVED METHOD FOR FILLING AN ELECTRON STORAGE RING FROM A SYNCHROTRON. Tigner, M. (Cornell Univ., Ithaca, NY). Part. Accel.; 6: No. 4, 211-212(1975).

By switching bunches back and forth between the storage ring and an injector synchrotron of circumference different from that of the storage ring, many bunches circulating in the storage ring can be combined rapidly into a single bunch. Such a technique can decrease the filling time for the storage ring significantly. An example is given in which it is estimated that 100 bunches circulating in a storage ring the size of the Cornell synchrotron can be combined into a single bunch in 1.7 sec. (auth)

Experimental Facilities

Refer also to abstract 3102.

3700 (JINR-R9-7339, pp 305-310) β- AND γ- SPECTROSCOPY AT THE U-120M ACCELERATOR. Zvol'ski, I. (Ustav Jaderne Fyziky, Rez, Czech.). 1973. (In Russian).

From 3rd symposium on the isochronous cyclotron U-120M and its uses for studies on nuclear physics; Ceske Budejovice, Czechoslovakia (14 May 1973). (Joint Inst. for Nuclear Research, Dubna (USSR)).

A brief study was made of the possibility of investigating with the following aspects of nuclear structure with the U-120 accelerator using β- and γ-spectroscopy: (1) the equilibrium shape

of nuclei in the ground and excited states; the Coriolis-interaction; and the structure of separate states of nuclei. (tr-auth)

3701 (LBL-4000, pp 377-378) EXTRACTION OF $^{20}Na^{+}$ IONS FROM A He JET ION SOURCE. Gough, R. A.; Littlejohn, D.; Vieira, D. J.; Cerny, J. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

3702 (N-75-21093) DESIGN, PERFORMANCE, AND CALCULATED ERROR OF A FARADAY CUP FOR ABSOLUTE BEAM CURRENT MEASUREMENTS OF 600-MeV PROTONS. Beck, S. M. (National Aeronautics and Space Administration, Langley Station, Va. (USA). Langley Research Center). Apr 1975. 39p. (NASA-TN-D-7858; L-9933). NTIS $3.75.

A mobile self-contained Faraday cup system for beam current measurements of nominal 600 MeV protons was designed, constructed, and used at the NASA Space Radiation Effects Laboratory. The cup is of reentrant design with a length of 106.7 cm and an outside diameter of 20.32 cm. The inner diameter is 15.24 cm and the base thickness is 30.48 cm. The primary absorber is commercially available lead hermetically sealed in a 0.32-cm-thick copper jacket. Several possible systematic errors in using the cup are evaluated. The largest source of error arises from high-energy electrons which are ejected from the entrance window and enter the cup. A total systematic error of -0.83 percent is calculated to be the decrease from the true current value. From data obtained in calibrating helium-filled ion chambers with the Faraday cup, the mean energy required to produce one ion pair in helium is found to be 30.76 +- 0.95 eV for nominal 600 MeV protons. This agrees well, within experimental error, with reported values of 29.9 eV and 30.2 eV. (auth)

3703 (TRI-75-2) EXPERIMENTAL FACILITIES AT TRIUMF. Pearce, R. M. (ed.). (Victoria Univ., British Columbia (Canada). Dept. of Physics). Aug 1975. 45p. Dep. NTIS (US Sales Only) $5.00.

TRIUMF is a sector-focused cyclotron for 525 MeV protons, with the first external beam being extracted late in 1974. The beam current is being increased while machine development and the installation of shielding take place. The ultimate design current is 100 μA. A summary is given of the properties of the beams, channels, and spectrometers which are installed or are in an advanced stage of planning. A brief discussion is given of those features of the cyclotron which make the beams at TRIUMF unique, the most important of these features being the acceleration of H^{-} ions. The Proton Area and the Meson Area are described. (auth)

3704 INSTALLATION OF A BREMSSTRAHLUNG GAMMA-RAY GENERATOR IN BDM SCATTERING CHAMBER. Shoda, K.; Sugawara, M.; Uegaki, J.; Tamae, T. (Tohoku Univ., Sendai (Japan). Lab. of Nuclear Science). Kakuriken Kenkyu Hokoku; 7: No. 1, 85-87(Jun 1974). (In Japanese).

A bremsstrahlung γ-ray generator was installed within a BDM (for broad-band analysis electromagnets) scattering chamber, and photonuclear reaction was measured in the same chamber. Construction of the system and measurement of γ-ray intensity are described. An electron beam hits a "radiator" target of gold upon entry to the chamber, and the bremsstrahlung γ-ray is generated. In front of the radiator target is a photonuclear reaction target being irradiated by the bremsstrahlung. The electron beam is bent 45 degrees, and goes out of the chamber. The bremsstrahlung, penetrating through the reaction target, goes straight and gets out of the chamber. Protons, α particles, and others emitted from the reaction target go through the BDM. Concerning γ-ray intensity, the proton emission from the reaction target ^{90}Zr by both electrons and γ-ray was studied with a Pt radiator. (JA)

3705 ABSORBED DOSE CONVERSION FACTOR FOR JAPM DOSIMETER EXPOSED TO HIGH ENERGY ELECTRONS IN WATER. Hoshino, K.; Inada, T.; Kawashima, K.; Hiraoka, T.; Matsuzawa, H. (National Inst. of Radiological Sciences, Chiba (Japan)). Nippon Igaku Hoshasen Gakkai Zasshi; 34: No. 12, 898-902(Dec 1974). (In Japanese).

Absorbed dose conversion factors, C_E, for the JAPM dosimeter were determined experimentally in water at depths of 1.5 cm, 2 cm and 4 cm, by means of betatron generated electric beams having initial energies of between about 15 MeV and 30 MeV. For determination of the absorbed dose in water, a Fricke dosimeter was used on the assumption that there is a constant G-value of 15.7 ferric ions per 100 eV over the electron energies of interest. The deviation between the experimental results for C_E and the values recommended by ICRU did not exceed 3%. It appears that the deviation may be more significant with increased initial electron energy. A relation was found between C_E and the most probable energy, (Ep)d, of electrons at depth, d, in water. (JA)

3706 METHOD OF MANUFACTURE OF A ROTATING ANODE FOR X-RAY SOURCES. Inoue, K. (to Inoue Japax Research Inc., Yokohama, Kanagawa (Japan)). Japanese Patent 1973-25850/B/. 4 Apr 1966. 2p. (In Japanese).

This invention relates to the manufacture of a rotary electrode for use in an X-ray source. Metal powders of W and Mo are agglomerated into a desired form by cathodic discharge sintering. The rotary electrode is anti-corrosive and has small specific resistance. Metal powders of W and Mo, or one of the powders and a plate of the other are inserted into a sintering furnace in two layers. The cathodic discharge sintering method, applying pressure and resistance welding, forms an agglomerate of W and Mo below the real density. (JA)

PHYSICS (ASTROPHYSICS AND COSMOLOGY)

Cosmic Radiation

Refer also to abstracts 3087, 3095, 3748, 3821, 3875, 3928, and 4246.

3707 (N-75-14691) LUNAR ELEMENTAL ANALYSIS OBTAINED FROM THE APOLLO GAMMA-RAY AND X-RAY REMOTE SENSING EXPERIMENT. Trombla, J. I.; Arnold, J. R.; Adler, I.; Metzger, A. E.; Reedy, R. C. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). 1974. 75p. (NASA-TM-X-72195). NTIS $4.25.

From Soviet-American conference on the cosmochemistry of the moon and planets; Moscow, USSR (4 Jun 1974).

Gamma ray and X-ray spectrometers carried in the service module of the Apollo 15 and 16 spacecraft were employed for compositional mapping of the lunar surface. The measurements involved the observation of the intensity and characteristic energy distribution of gamma rays and X-rays emitted from the lunar surface. A large scale compositional map of over 10 percent of the lunar surface was obtained from an analysis of the observed spectra. The objective of the X-ray experiment was to measure the K spectral lines from Mg, Al, and Si. Spectra were obtained and the data were reduced to Al/Si and Mg/Si intensity ratios and ultimately to chemical ratios. The objective of the gamma-ray experiment was to measure the natural and cosmic ray induced activity emission spectrum. At this time, the elemental abundances for Th, U, K, Fe, Ti, Si, and O have been determined over a number of major lunar regions. (auth)

3708 (N-75-14700) TIME-DEPENDENT DIFFUSION CONVECTION MODEL FOR THE LONG-TERM MODULATION OF COSMIC RAYS. Gallagher, J. J. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). Jun 1974. 42p. (NASA-CR-141146; TR-74-114). NTIS $3.75.

A model is developed which incorporates to first order the direct effects of the time dependent diffusive propagation of interstellar cosmic rays in a slowly changing interplanetary medium. The model provides a physical explanation for observed rigidity-dependent phase lags in modulated spectra (cosmic ray hysteresis). The average distance to the modulating boundary during the last solar cycle is estimated. (STAR)

3709 (N-75-14701) SPECTRUM OF COSMIC ELECTRON WITH ENERGIES BETWEEN 6 AND 100 GeV. Meegan, C. A.; Earl, J. A. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). Oct 1974. 53p. (NASA-CR-141287; TR-75-019). NTIS $4.25.

This experiment was carried out during three balloon flights which provided a total exposure of 3500 + or - 60 sq m sec sterad at an average depth of 4.8 g/sq cm. The detector, in which the development of cascade showers in a 33.7 rl absorber was sampled by 10 scintillation counters and 216 Geiger-Mueller tubes, was calibrated at the Cornell Electron Synchrotron, the separation of cosmic electrons from the nuclear background was confirmed by extensive analysis of data from the flights, from the calibration and from ground level exposure. The spectral intensity of primary cosmic ray electrons was found in particles/sq m sec sterad GeV. Similarly, the ground level spectrum of secondary cosmic ray electrons was also found. The steepness of the spectrum of cosmic electrons relative to that of nuclei implies one of the following conclusions: either the injection spectrum of electrons is steeper than that of nuclei, or the electron spectrum has been steepened by Compton/synchrotron losses in the energy range covered by the experiment. (auth)

3710 (N-75-15584) PHYSICS OF COSMIC RAYS. Murzin, V. S. Dec 1974. Translation of Fizika Kosmicheskikh Luchey, Moscow University Press, Moscow, 1970. (NASA-TT-F-16171; TT-73-58027). 285p. NTIS $8.75.

3711 (N-75-18146) COSMIC RAY DIFFUSION: REPORT OF THE WORKSHOP IN COSMIC RAY DIFFUSION THEORY. Birmingham, T. J.; Jones, F. C. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Feb 1975. 22p. (NASA-TN-D-7873; G-7542). NTIS $3.25.

From workshop in cosmic ray diffusion theory; Greenbelt, MD (16 May 1974).

A workshop in cosmic ray diffusion theory was held at Goddard Space Flight Center on May 16-17, 1974. Topics discussed and summarized are: (1) cosmic ray measurements as related to diffusion theory; (2) quasi-linear theory, nonlinear theory, and computer simulation of cosmic ray pitch-angle diffusion; and (3) magnetic field fluctuation measurements as related to diffusion theory. (auth)

3712 (N-75-19120) ORIGIN OF COSMIC RAYS. Stecker, F. W. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Mar 1975. 14p. (NASA-TM-X-70848; X-602-75-58). NTIS $3.25.

Using recent surveys of molecular clouds and gamma rays in the galaxy, it is possible to determine the distribution of 1 to 10 GeV cosmic-ray nucleons in the galaxy. This distribution appears to be identical to the supernova remnant distribution to within experimental error and provides strong support for the hypothesis that supernovae produce most of the observed cosmic rays. This distribution resembles that of OB associations average age approximately 30 million years suggesting that cosmic rays are produced by population objects about 30 million years after their birth. (auth)

3713 (N-75-23464) DYNAMIC MODEL FOR THE TIME EVOLUTION OF THE MODULATED COSMIC-RAY SPECTRUM. OGallagher, J. J.; Maslyar, G. A. III. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). May 1975. 34p. NTIS $3.75.

A recently developed model predicts an energy dependent phase lag in the modulated cosmic ray density U(t) given by U(t) approximately equal to US(t-tau) where US is the solution to the Fokker-Planck equation under time independent conditions and tau is the average time spent by particles inside the modulating region. The delay times tau are functions of modulating parameters R (the radius of the modulating cavity), V (the solar wind velocity), and K (the effective average diffusion-coefficient which is a function of energy). This model is applied to predict the time evolution of the modulated cosmic ray proton spectrum over a simulated solar cycle. A modulation produced mostly by varying R over the solar cycle is less consistent with the observations. (auth)

3714 (NP-20526, pp 79-82) HIGH ENERGY HADRONS AND γ RAYS OF AIR SHOWERS. Matano, T. (Saitama Univ., Urawa, Japan); Machida, M.; Ishizuka, T.; Ohta, K.; Tsushima, I.; Kawasumi, N.; Hashimoto, K. 1974.

In Institute for Nuclear Study annual report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

3715 (NP-20526, pp 85-86) STUDY OF AIR SHOWERS OF ENERGIES ABOVE 10^{17} eV. Kawaguchi, S.; Suga, K.; Sakuyama, H.; Torii, R. 1974.

In Institute for Nuclear Study annual report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

3716 (NP-20526, pp 119-121) OBSERVATION OF COSMIC-RAY PARTICLES WITH $Z \geq 50$. Doke, T. (Waseda Univ., Japan); Okamoto, H.; Shibamura, E.; Hayashi, T.; Miyajima, M.; Ito, K.; Yanagimachi, T.; Kobayashi, S.; Saito, T.; Nagata, K. 1974.

In Institute for Nuclear Study annual report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

3717 (NP-20526, pp 128) COSMIC-RAY INTERACTIONS ON THE LUNAR SURFACE. 1974.

In Institute for Nuclear Study annual report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

3718 SPACE DOSIMETRY. Francois, F.; Portal, G. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Protection). pp 171-178 of 8th National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French)

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

Some aspects of the problems raised by the dosimetry of cosmic radiation and their solutions as well as the dosimetric results during experiments aboard Apollo XVI and XVII space vehicles or flights of the SST Concorde are reviewed. (FR)

3719 TIME DELAY BETWEEN EXPLOSIVE NUCLEOSYNTHESIS AND COSMIC-RAY ACCELERATION.

Cassé, M.; Soutoul, A. (Centre d'Etudes Nucleaires de Saclay, France). Astrophys. J. Lett. 200: No. 2, L75-L76 (1 Sept 1975).

Pure electron capture nuclei synthesized during explosive events could, under special conditions, be present in the relativistic cosmic radiation, providing an opportunity to set limits on the time elapsed between nucleosynthesis and acceleration of cosmic-ray nuclei. In this respect, measurement of the cobalt abundance in relativistic cosmic rays seems the more promising test for the near future. (auth)

3720 A STUDY OF DAYS SHOWING NON-FIELD-ALIGNED DIFFUSION VECTORS OF COSMIC RAY DIURNAL ANISOTROPY. Kane, R.P. (Physical Research Laboratory, Ahmedabad, India). J. Geophys. Res. 80: No. 25, 3509-3518 (1 Sept 1975).

Days when significant non-field-aligned diffusion of cosmic ray diurnal anisotropy occurred during 1965–1968 are studied in detail. It is shown that whereas a large hour-to-hour and/or day-to-day variability of the interplanetary ecliptic magnetic field direction may favor non-field-aligned diffusion, it is not a necessary condition. Some characteristics of the diurnal anisotropy seem to indicate the possibility of more than one mechanism (sources and/or sinks) operating simultaneously, distorting the usually assumed simple picture of a radially outward convection and a field-aligned inward diffusion giving the observed vector along about 1800 LT in space. (auth)

3721 THE ENERGY DISTRIBUTION OF VERY HEAVY COSMIC RAY NUCLEI WITHIN THE PENUMBRA AT PALESTINE, TEXAS. Mathiesen, O.; Larsson, L.; Andersson, R. (Department of Physics, University of Lund, Lund, Sweden). J. Geophys. Res. 80: No. 25, 3519-3524 (1 Sept 1975).

The low-energy end of the rigidity spectrum of cosmic-ray nuclei with atomic numbers $Z \geq 18$, recorded in a balloon flight conducted from Palestine, Texas, has been compared with a corresponding theoretical spectrum based on the computations by Shea and Smart. The two distributions are found to be in qualitative agreement with each other. The spread in apparent particle charge, caused by the theoretical distribution of particle velocity at Palestine, has been calculated for detectors with different response functions. The resulting structure of the predicted charge spectrum of iron group nuclei is found to be in good agreement with corresponding experimental data. (auth)

3722 SEARCH FOR FLASHES OF COSMIC γ RAYS AT ENERGY $E_\gamma \geq 100$ MeV. Belyaevskii, A.I.; Bokov, V.L.; Bocharkin, V.K.; Bugakov, I.F.; Gorodinskii, G.M.; Derevitskii, Yu.G.; Kruglov, E.M.; Pyatigorskii, G.A.; Chulkin, E.I. (A. F. Ioffe Physico-technical Institute, USSR Academy of Sciences). JETP Lett. 21: No. 12, 345-346 (20 June 1975).

The upper limit of the frequency of appearance of flashes of cosmic γ rays at energy $E_\gamma \geq 100$ MeV was estimated from data on the distribution of the number of time intervals with specified number of photons, as registered by a γ telescope on the satellite "Cosmos-561." Averaged energy and temporal characteristics of the flash are presented. (auth)

3723 $\langle r^2 \rangle$ AND $\langle E^2 r^2 \rangle$ OF THE SURVIVING NUCLEON IN AS. Oda, Hiroshi; Dake, S. (Kobe Univ. (Japan). Faculty of Science). Uchusen Kenkyu; 18: No. 4, 325-335(Jun 1974). (In Japanese).

The behavior of surviving nucleons has already been reported because of their importance in AS phenomenon. The result of calculation of $\langle r^2 \rangle$ and $\langle E^2 r^2 \rangle$ with a diffusion equation is reported. Atmosphere was assumed to be isothermal, and the distributions of inelasticity were calculated in a few cases. The electromagnetic cascade method of calculation was applicable. The calculation was performed in case of the uniform distribution of $\overline{K} = 1/2$ and delta = 0 and 1/2. $\langle r^2 \rangle$ is very sensitive to the behavior of φ (K) around K = 1. In the case of $\delta = 1/2$, $\langle r^2 \rangle$ does not exist. The diffusion of surviving nucleons depends strongly on inelasticity, but is not effective for $\langle E^2 r^2 \rangle \cdot \sqrt{\langle r^2 \rangle}/R$ in case of φ (K) = δ (K – $\overline{K}$) and $\overline{K} = 1/2$, $\langle E^2 r^2 \rangle / \sqrt{\langle p_\parallel^2 \rangle} H$ in case of φ (K) = δ (K – $\overline{K}$) and $\overline{K} = 1/2$, and $\langle E^2 r^2 \rangle / \sqrt{\langle p_\parallel^2 \rangle} H$ in case of φ (K) = 1 and $0 \leqq K \leqq 1$ are shown in figures. Wherein H represents scale height (~b km) of atmosphere; φ (K) represents inelastic distribution, and R is the constant with unit of length. (JA)

3724 MEASUREMENT OF GAMMA-RAY INTENSITY BY A LARGE AREA CHAMBER AT MT. FUJI. Torii, S. (Kyoto Univ. (Japan). Faculty of Science). Uchusen Kenkyu; 18: No. 4, 404-439(Jun 1974). (In Japanese).

Gamma-ray energy spectra in the energy range between 1.5 and 100 TeV were obtained by a large area emulsion chamber exposed at Mt. Fuji for 317 days. The chamber consists of thin part and thick part. The ratio of gamma-ray and Pd-jet was measured by obtaining Δt distribution. Gamma-ray energy spectra and angular distribution were obtained by the thick chamber. Gamma-ray spectra were also obtained by the thin chamber. A new method for energy determination, which used only the initial stage of shower growth, was applied for the data from the thin chamber, and the accuracy of the method was within ± 30% as compared with conventional method. Both spectra obtained from the thin and thick chambers were not different from each other. The gamma-ray angular distribution was expressed by the approximation of $\cos^n\vartheta$, and $n = 9 \pm 1$ for the energy over 1.5 TeV, and $n = 8.5 \pm 1.5$ for the energy over 15 TeV. The obtained spectra were compared with the results obtained at Mt. Norikura and Mt. Chacaltaya. It can be said that the gamma-ray energy spectrum is constant at deep places in atmosphere, and energy dependence is not seen. Total gamma ray energy of γ-ray families was obtained. The power of the spectra was $\beta = -1.2 \pm 0.1$, but a slight bending is seen for the energy range more than 500 TeV. Super-high energy gamma-ray seen in the thin chamber is discussed. (TSS)

3725 SUPERSONIC COLLAPSE OF LANGMUIR WAVES. Degtyarev, L. M.; Zakharov, V. E. (Applied Mathematics Inst., Moscow). JETP Lett. (USSR) (Engl. Transl.); 21: No. 1, 4-5 (5 Jan 1975).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 21: No. 1, 9-12(5 Jan 1975).

Exact power-law solutions that cause the collision integral of the Boltzmann kinetic equation to vanish are obtained. (auth)

3726 MULTIPLE MUONS IN THE UTAH DETECTOR. II. COMPARISON WITH A HADRONIC SCALING MODEL. Elbert, J.W.; Keuffel, J.W.; Lowe, G.H.; Morrison, J.L. (Department of Physics, University of Utah, Salt Lake City, Utah 84112); Mason, G.W. Phys. Rev. D 12: No. 3, 660-672 (1 Aug 1975).

Detailed predictions are made for the multiple-muon–event rates measured in the underground muon experiment at the University of Utah. In our calculations, Feynman scaling is used to project inclusive proton-nucleus particle production cross sections from 19.2-GeV accelerator measurements to the ultrahigh-energy region from 1 TeV to 10 000 TeV. The multiplicity distribution is assumed to follow Koba-Nielsen-Olesen scaling. The primary cosmic-ray spectrum and composition are extrapolated upwards from the direct measurements made at less than a few TeV. Rates are calculated for detected multiplicities $n_D = 1$–30 observed over a zenith angle range 30°–72° and over a depth range of 1.5×10^5–10^6 g cm^{-2}. Good agreement between predictions and measurements has been obtained with scaling and such a simple extrapolation to higher energies of the directly measured primary spectrum and composition. (auth)

3727 MULTIPLE MUONS IN THE UTAH DETECTOR. I. MEASUREMENT. Lowe, G.H.; Larson, M.O.; Bergeson, H.E.; Cardon, J.W.; Keuffel, J.W.; West, J. (Department of Physics, University of Utah, Salt Lake City, Utah 84112). Phys. Rev. D 12: No. 3, 651-659 (1 Aug 1975).

Final and more extensive data on multiple-muon events deep underground in the Utah muon detector are presented as rates for multiplicities 1 to 5 in a fiducial plane of 80 m^2. New results are presented for showers having muon multiplicities from 10 to 50 in a fiducial plane of 100 m^2. The measurements are taken at depths ranging from a minimum of 1.5×10^5 g cm^{-2} to a maximum of 1.0×10^6 g cm^{-2}. The energy per nucleon of the primaries which create the muon shower ranges from 10^{13} to 10^{16} eV. (auth)

3728 DIFFUSION OF COSMIC RAYS IN NON-THERMAL RADIO SOURCES. Wilson, A. S. (Sterrewacht, Leiden). Astron. Astrophys.; 43: No. 1, 1-12(Sep 1975).

Spherically-symmetric models of extended non-thermal radio sources are investigated in which relativistic particles are generated by a compact source (e.g. pulsar) in the center (r = 0) and then diffuse away, losing energy by various processes. The main aim is to calculate the density of relativistic electrons N(E, r, t) taking account of diffusion coefficients D and energy loss rates dE/dt which may be functions of energy, position and time. In Section 2 a simple physical picture is applied to solve problems in which D and dE/dt are arbitrary functions of energy and time, but independent of position. Special cases of astrophysical interest are then considered, in particular losses to ionization, bremsstrahlung, synchrotron radiation, inverse Compton scattering and uniform adiabatic expansion. Section 3 treats energy and position dependent parameters, but, for simplicity, the problem is now restricted to steady-state solutions. N(E, r) is obtained here by a formal solution of the diffusion-loss equation. Detailed computations of the synchrotron spectra as a function of radius are made for representative dependences of D and dE/dt on energy and position, and the form of the spectrum of the integrated emission is calculated. The integrated spectrum of the Crab Nebula from radio to x-rays may be explained in terms of continuous injection of relativistic electrons having a power-law energy spectrum ($n_s(E_0) \propto E_0^{-1.52}$) over the whole range of energies (10^8eV to 10^{14}eV) into a magnetic field which decreases as r^{-1}. A more detailed comparison of the structure of the nebula

and other radio sources with the models will be presented elsewhere. (auth)

Stars

Refer also to abstracts 3719, 3728, 3794, 3797–3799, 3802, 3804, 3826, 3842, 3844, 3853, 3857, 4338, 4460, 4474, 4579, 4595, 4603, and 4610.

3729 (LA-UR-75-735) OBSERVATIONS OF GAMMA-RAY BURSTS. Strong, I. B.; Klebesadel, R. W.; Evans, W. D. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-ENG-36. 24p. (CONF-751202-1). Dep. NTIS $4.50.

From 7th Texas symposium on relativistic astrophysics; Dallas, Texas, USA (16 Dec 1974).

Observational data on gamma-ray bursts are reviewed. Information is grouped into temporal properties, energy fluxes and spectral properties, and directions and distributions of the sources in space. (BJG)

3730 (LA-UR-75-1630) MASS OF AC ANDROMEDAE. King, D. S.; Cox, A. N.; Hodson, S. W. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-ENG-36. 8p. (CONF-750940-3). Dep. NTIS $4.00.

From 29th colloquium of the I.A.U. multiple periodic variable stars; Budapest, Hungary (1 Sep 1975).

Calculations indicate that AC Andromedae is population I rather than population II. A mass and radius for this star are calculated using a new set of opacities for the Kippenhahn Ia mixture. It is concluded that the mass is too high for an ordinary RR Lyrae star. (BJG)

3731 (LA-UR-75-1769) NON-LINEAR RADIATIVE TRANSFER MODEL OF SW ANDROMADAE. Davis, C. G. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-ENG-36. 12p. (CONF-750940-2). Dep. NTIS $4.00.

From 29th colloquium of the I.A.U. multiple periodic variable stars; Budapest, Hungary (1 Sep 1975).

The following parameters were used to develop a model of SW And.: Log L/L/sub sun/ equals 1.6, Log T/sub eff/ equals 3.835 and M equals 0.6 M/sub sun/. Variable Eddington radiative transfer coupled hydrodynamic calculations, for gray and multi-group Cox-King (King-1A) mixture, were completed. In a comparison of the numerical results to observations, it appears that a multi-frequency radiative transfer calculation is needed since improvements in the B-V, log T/sub eff/ relation are obtained. It is proposed to use these atmospheres in a non-LTE line transfer code in order to make the more direct connection to observations. (auth)

3732 (N-75-15520) HYDRODYNAMIC MODELS OF A CEPHEID ATMOSPHERE. Karp, A. H. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Nov 1974. 192p. (NASA-TM-X-70803; X-671-74-336). NTIS $7.00.

Thesis. Submitted to Univ. of Maryland, College Park.

A method for including the solution of the transfer equation in a standard Henyey type hydrodynamic code was developed. This modified Henyey method was used in an implicit hydrodynamic code to compute deep envelope models of a classical Cepheid with a period of 12(d) including radiative transfer effects in the optically thin zones. It was found that the velocity gradients in the atmosphere are not responsible for the large microturbulent velocities observed in Cepheids but may be responsible for the occurrence of supersonic microturbulence. It was found that the splitting of the cores of the strong lines is due to shock induced temperature inversions in the line forming region. The adopted light, color, and velocity curves were used to study three methods frequently used to determine the mean radii of Cepheids. It is concluded that an accuracy of 10 percent is possible only if high quality observations are used. (auth)

3733 (N-75-15522) SUPERNOVA 1972e IN NGC 5253. Kirshner, R. P.; Oke, J. B. (Hale Observatories, Pasadena, Calif. (USA)). 1975. 30p. (NASA-CR-141959). NTIS $3.75.

New absolute energy distributions of the Type 1 supernova 1972e in NGC 5253 extending to about 700 days after maximum light were obtained. A physical model of the expanding envelope, based on the identification of the feature at 6550 A with H-alpha, is proposed. It is described as a differentially expanding atmosphere, with electron density ranging from 10 to the 10th power near maximum light to about 10 to the 7th power, 340 days later, illuminated by a photosphere with temperature in the range 10,000 K to 7,000 K. More than 200 days after maximum, the spectrum was dominated by four features between 4200 A and 5500 A. Three of these four features matched the blended emissions from over 100 lines of Fe II. Possible identifications of the fourth feature with Mg I lambda 4571 or permitted lines of Fe II are also discussed. (auth)

3734 (N-75-22214) TIME VARIATIONS OF UV EMISSION FEATURES OF Be STARS. Final Report, 1 August 1972–31 January 1975. Bahng, J. D. R. (Northwestern Univ., Evanston, Ill. (USA). Dept. of Astronomy). 31 Jan 1975. 35p. NTIS $3.75.

The UV spectra of three Be stars (gamma Cas, sigma Tau, eta Cen) were studied. Of the six Be stars observed in the first four lines of the Balmer series, three stars showed at least one of the Balmer lines to be variable in the equivalent width amounting to a few percent with time scales of 3 to 30 minutes. Photoelectric spectrum scans of five southern Wolf-Rayet stars showed night-to-night variations. A simple model is proposed to account for the behavior of these emission lines. Scans of gamma square Vel showed rapid variations of emission strengths of He II 4686 and C III–IV 4650. These variations have time scales of 1 minute and longer. Night-to-night variations were also found. Scans of four Be stars in H alpha showed a definite variation of 3 to 4 percent, with time scales of 1 minute and longer in sigma Tau. In 48 Per and kappa Dra the variations are not as well established. No variation of any significance was found for nu Gem. (auth)

3735 (N-75-23421) SAS-2 HIGH-ENERGY GAMMA-RAY OBSERVATIONS OF THE VELA PULSAR. Thompson, D. J.; Fichtel, C. E.; Kniffen, D. A.; Oegelman, H. B. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Apr 1975. 14p. (NASA-TM-X-70877; X-662-75-102). NTIS $3.25.

The second Small Astronomy Satellite high-energy (greater than 35 MeV) gamma-ray telescope detected pulsed gamma-ray emission at the radio period from PSR 0833-45, the Vela pulsar, as well as an unpulsed flux from the Vela region. The pulsed emission consists of two peaks, one following the radio peak by about 13 msec, and the other 0.4 period after the first. The luminosity of the pulsed emission above 100 MeV from Vela is about 0.1 that of the pulsar NP0532 in the Crab nebula, whereas the pulsed emission from Vela at optical wavelengths is less than 0.0004 that from the Crab. The relatively high intensity of the pulsed gamma-ray emission and the double peak structure, compared to the single pulse in the radio emission, suggests that the high energy gamma-ray pulsar emission may be produced under different conditions from those found at lower energies. (auth)

3736 (UCRL-76947) NEUTRINO FLOW AND GRAVITATIONAL COLLAPSE. Wilson, J. R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 18 Aug 1975. 36p. (CONF-750744-2). Dep. NTIS $5.00.

From meeting of physics and astrophysics of neutron stars and black holes; Varenna, Italy (14 Jul 1975).

The discovery of neutral currents in neutrino interactions has made necessary the recalculation of the neutrino flow during stellar collapse. Neutral currents cause a coherent scattering cross section of complex nuclei proportional to the square of the atomic weight. This allows neutrinos to escape easily from the hot, dense center where only free baryons exist. The neutrinos then interact strongly in the outer region of high atomic weight and, under certain circumstances, produce a supernovae-like explosion in the outer reaches of the star, leaving a neutron star behind. For an explosion to occur, the scattering in the envelope of heavy nuclei must be greater than the scattering of the free baryons in the core. In particular, with Friedman's interpretation of Weinberg's theory, the cross section ratio is insufficient to produce an explosion. Other theories state that suppressing the free baryon cross section does lead to an explosion. (auth)

3737 (UCRL-76967) NUMERICAL STUDY OF ROTATING RELATIVISTIC STARS. Wilson, J. R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Aug 1975. 54p. (CONF-750744-1). Dep. NTIS $5.75.

From meeting of physics and astrophysics of neutron stars and black holes; Varenna, Italy (14 Jul 1975).

The equations of structure for rotating stars in general relativity are presented and put in a form suitable for computer calculations. The results of equilibrium calculations for supermassive stars, neutron stars, and magnetically supported stars are reported, as are calculations of collapsing, rotating, and magnetized stars in the slowly changing gravitational field approximation. (auth)

3738 SAS-2 HIGH-ENERGY GAMMA-RAY OBSERVATIONS OF THE VELA PULSAR. Thompson, D.J.; Fichtel, C.E.; Kniffen, D.A.; Ögelman, H.B. (NASA/Goddard Space Flight Center, Greenbelt, Maryland). Astrophys. J. Lett. 200: No. 2, L79-L82 (1 Sept 1975).

The Second Small Astronomy Satellite (SAS-2) high-energy (>35 MeV) γ-ray telescope has detected pulsed γ-ray emission at the radio period from PSR 0833–45, the Vela pulsar, as well as an unpulsed flux from the Vela region. The pulsed emission consists of two peaks,

following the single radio peak by about 13 ms and 48 ms. The luminosity of the pulsed emission above 100 MeV from Vela is about 0.1 that of the pulsar NP 0532 in the Crab nebula, whereas the pulsed emission from Vela at optical wavelengths is less than 2×10^{-4} that from the Crab. The relatively high intensity of the pulsed γ-ray emission, and the double peak structure, compared with the single pulse in the radio emission, suggest that the high-energy γ-ray pulsar emission may be produced under different conditions from those at lower energies. (auth)

3739 ON THE LOWER MASS LIMIT FOR THE CARBON DETONATION SCENARIO. Endal, A.S.; Sparks, W.M. (Laboratory for Optical Astronomy, NASA/Goddard Space Flight Center). Astrophys. J. Lett. 200: No. 2, L77-L78 (1 Sept 1975).

The lower mass limit for carbon detonation ($\sim 4\,M_\odot$) is due to an argument by Paczynski that stars in the 1.4–3.5 $M_\odot$ range will lose their envelopes prior to carbon detonation. This argument is based on two criteria for mass loss: (1) the envelope is unstable to adiabatic oscillations, and (2) the total energy of the envelope is positive. Recent hydrodynamic calculations of red-giant envelopes have shown that the envelopes are highly nonadiabatic, and that the second criterion is not a sufficient condition for mass loss. Thus a calculation which takes into account the nonadiabatic nature of the envelope is required to determine the lower mass limit for carbon detonation. This lower mass limit is directly related to the formation mechanisms and statistics of supernovae and pulsars. (auth)

3740 ENTROPY EXTREMUM OF RELATIVISTIC SELF-BOUND SYSTEMS: A GEOMETRIC APPROACH. Katz, J.; Manor, Y. (The Racah Institute of Physics, The Hebrew University of Jerusalem, Jerusalem, Israel). Phys. Rev. D 12: No. 4, 956-964 (15 Aug 1975).

Conditions for entropy extremum of self-bound relativistic systems of particles, in stationary axisymmetric motion, are obtained under the following constraints: (i) The system is kept isolated in a geometrical sense, implying that the total mass-energy and total angular momentum, defined by the asymptotic behavior of the metric, are kept constant, (ii) the total number of particles is kept constant, and (iii) Einstein's constraint equations are imposed on a spacelike hypersurface. It is shown that if the system is in mechanical equilibrium, the total entropy is an extremum for all trial nonequilibrium configurations that satisfy the constraints and respect the symmetry, if and only if (i) Einstein's dynamical equations are satisfied, (ii) the temperature and the gravito-chemical free energy, as seen from infinity, are constant, and (iii) the system is rigidly rotating. The proof does not depend on a particular functional expression for the mass or for the angular momentum; consequently, no related Lagrange multipliers have been used. (auth)

3741 METAL ABUNDANCES OF DRACO AND EIGHT GALACTIC GLOBULAR CLUSTERS. Canterna, R. (Department of Astronomy, University of Washington). Astrophys. J. Lett. 200: No. 2, L63-L66 (1 Sept 1975).

Photometric metal abundances of individual giants in the Draco galaxy and eight globular clusters have been obtained using the C, M, T_1, T_2 photometric system. This new broad-band system was designed specifically for photometric abundance determinations of G and K giants. The results show that [Fe/H] = −3.0 for the Draco giants, much lower than M92. M22 is metal-deficient, [Fe/H] = −2.0, in agreement with its horizontal-branch morphology, but inconsistent with the slope of the red-giant branch. [Fe/H] of NGC 4147 and NGC 7006 is similar to M22. (auth)

3742 G29-38 AND G38-29; TWO NEW LARGE-AMPLITUDE VARIABLE WHITE DWARFS. McGraw, J.T.; Robinson, E.L. (McDonald Observatory and Department of Astronomy, University of Texas at Austin, Austin, Texas 78712). Astrophys. J. Lett. 200: No. 2, L89-L93 (1 Sept 1975).

G28-38 and G38-29 are shown to be luminosity-variable white dwarfs whose characteristics are similar to those of HL Tau-76. Power spectrum analysis shows that the light curves of both stars have a complex low-frequency structure that is variable with time. It is suggested that many but not all of the features in the power spectra of these two stars could result from nonradial pulsations in a rotating white dwarf. (auth)

3743 THE DEMISE OF THE DEGENERATE M STARS. Liebert, J. (Department of Astronomy, University of California, Berkeley, CA 94720). Astrophys. J. Lett. 200: No. 2, L95-L98 (1 Sept 1975).

Lick image tube spectrophotometry is presented of suspected degenerate M (DM) stars and of the faintest of the suspected Hyades red subluminous (RSL) star suspects. All appear to be dwarf M's or subdwarfs. It is believed that these results, taken together with recent work by Greenstein and with Naval Observatory parallaxes, leave no remaining degenerate M or strong Hyades RSL candidates. (auth)

3744 VARIABLE RADIO EMISSION FROM UX ARIETIS (HD 21242). Gibson, D.M. (University of Virginia and National Radio Astronomy Observatory); Hjellming, R.M.; Owen, F.N. Astrophys. J. Lett. 200: No. 2, L99-L102 (1 Sept 1975).

Variable radio emission from the spectroscopic binary UX Ari has been detected at frequencies of 2695, 5010, and 8085 MHz using the NRAO 91-m transit telescope and the NRAO four-element interferometer. The UX Ari radio source was present on all 13 days the source was observed with the interferometer, and was probably present on six of the 10 days the source was observed at 5010 MHz with the 91-m telescope. The radio behavior included at least two Algol-type flares, and during the decay of the flare of 1974 August 11–14 the spectrum became inverted, indicating the nonthermal nature of the radio emission. (auth)

3745 RAPIDLY ROTATING FLUID BODIES IN GENERAL RELATIVITY. Butterworth, E.M.; Ipser, J.R. (University of Chicago). Astrophys. J. Lett. 200: No. 2, L103-L106 (1 Sept 1975).

A new self-consistent-field method for numerically constructing rapidly rotating fluid bodies in general relativity has been developed. Results which emerge from using it to build uniformly rotating homogeneous bodies are discussed. The results reveal that, in contrast to the Newtonian sequence of Maclaurin spheroids, the relativistic sequences in most, and probably all, cases terminate at eccentricities <1 where the centrifugal and gravitational accelerations at the equator become equal. The results also suggest that a highly relativistic rotating body, due to certain effects, might evolve toward a nearly spherical configuration as it contracts. (auth)

3746 INTERSTELLAR BUBBLES. Castor, J.; McCray, R.; Weaver, R. (Joint Institute for Laboratory Astrophysics, University of Colorado). Astrophys. J. Lett. 200: No. 2, L107-L110 (1 Sept 1975).

Early-type stars blow bubbles in the interstellar medium. The radii of the bubbles are typically 30 pc. Typical conditions in their interiors are $T\simeq10^6$K and $n\simeq0.01$ cm^{-3}. The dense shell of swept-up interstellar gas that surrounds them is likely to trap the ionization front and may also have an outer layer of H_2. The column density of O VI in the interior is in accord with observations by the *Copernicus* ultraviolet telescope. (auth)

3747 PENETRATION OF CONVECTIVE ENVELOPE INTO STELLAR CORE AND EXISTENCE OF NEUTRINO LOSS. Nomoto, K. (Tokyo Univ. (Japan). Coll. of General Education). Prog. Theor. Phys. (Kyoto); 52: No. 2, 453-470(Aug 1974).

Evolution of stars of masses $60M_\odot$, $20M_\odot$ and $12M_\odot$ is computed mainly for a limiting case where neutrino loss due to the universal Fermi interaction is completely neglected. Convective envelope penetrates deeply into the highly evolved core, but the depth of penetration is found to depend on the stellar mass and the efficiency of convective energy transport. When the mixing proceeds quickly, the core mass is reduced finally below the Chandrasekhar limit and electrons become degenerate. When the mixing is relatively slow, on the other hand, decomposition of iron takes place in the core. When the degenerate core is formed, hydrogen is depleted uniformly in the envelope and the lifetime of this phase is much longer than one in the helium-burning phase. Moreover, in the bulk of that lifetime, the star remains a red supergiant, which is a peculiar star in its chemical composition. Thus both observed number ratio of blue to red supergiants and relative paucity of peculiar red supergiants support the existence of the neutrino loss, under the condition that the mixing length of convection is not appreciably smaller than unit scale height of pressure in the convective envelope. When the neutrino loss is included, on the other hand, only a star as massive as 60 $M_\odot$ may become a peculiar star as a result of the deep convective mixing, while the star of mass smaller than $30M_\odot$ does not. Discussion concerning an origin of highly luminous peculiar stars is also given. (auth)

3748 OBSERVATION OF SOFT X-RAY FROM SCO X-1. Matsuoka, M.; Miyamoto, S.; Oda, M.; Ogawara, Y.; Takagishi, K. (Osaka City Univ. (Japan). Faculty of Science). Tokyo Daigaku Uchu Koku Kenkyusho Hokoku; 10: No. 3, pt.B, 631-640(Sep 1974). (In Japanese).

This paper presents the results of three observations on the soft x-ray from SCO X-1 by using three rockets. The detectors used for the detection of the soft x-ray from SCO X-1 were proportional counters with thin polypropylene window, and sealed type proportional counters and NaI (Tl) scintillation counters were effective for obtaining broad range spectra of x-ray energy. Direction of x-ray detectors was corrected, and the error of the relative angle between the detectors and SCO X-1 was made less than 1^0. The rockets made constant spin and precession, and the obtained data were corrected for them. Thermal radiation parameters were determined from the spectra for the energy more than a few keV. All the results were in good agreement with the thermal radiation spectra considering the Gaunt factor. The obtained thermal radiation was extrapolated to the region of soft x-ray, and the difference between the extrapolated value and

observed one of soft x-ray gave the absorption due to interstellar gas. From these results, the linear density of the neutral gas in interstellar space was obtained. Values of the linear density (N_H) obtained by three observations were different from each other, and showed variation with time. When a uniform high temperature model is applied for SCO X-1, the minimum value of the linear density N_H was less than 5×10^{20} H/cm^2 and the maximum value was 5×10^{21} H/cm^2 (TSS)

3749 RECENT X-RAY ASTRONOMY. Oda, Minoru (Tokyo Univ. (Japan). Inst. of Space and Aeronautical Science). Denki Gakkai Zasshi; 94: No. 11, 973-978(Nov 1974). (In Japanese).

Recent topics on x-ray astronomy are described. The x-ray astronomy is a new field of astronomy. At present, about 150 stars emit strong x-rays. The radiating energy from the x-ray stars is unthinkably large, and the origin of this energy aroused strong interest for research. Some x-ray stars are considered to be supernovae. As an example, the Crab Nebula having been left after large nuclear fusion explosion emits strong x-ray, and the mechanism of its x-ray emission is synchrotron radiation. High energy electrons moving on spiral orbits in a strong magnetic field radiate electromagnetic waves. For the efficient and rapid acceleration of electrons, pulsers which are the rotating stars with high density were considered. One of the high density stars is neutron star, and an example was discovered in the Crab Nebula. Close binary stars also emit x-ray. When material from the principal star flows to the high density star, a large amount of energy is released. There are other x-ray stars which cannot be considered as supernovae or close binary stars. A bright x-ray star named CygX-1 has been studied by various methods. The mass of the CygX-1 was determined, and is three times as heavy as the mass of the sun. The CygX-1 may be a black-hole. (TSS)

3750 FAR ULTRAVIOLET SPECTRUM OF ARCTURUS. McKinney, W. R. Baltimore; Johns Hopkins Univ. (1974). 154p. University Microfilms Order No. 75-12,991.

Thesis (Ph.D.).

The far ultraviolet spectrum (1180 A–1980 A) of the K2III p star Arcturus has been measured by a new rocket borne telescope-ten channel spectrometer with greater spectral resolution and sensitivity than was previously obtained. The following results are presented: a new measurement of the HI L alpha and OI 1304 fluxes. The HI L alpha result is much lower than previous results indicating this line may be variable. The possible discovery of a third emission feature at 1511 A +- 5A. Low upper limits on other line and continuum emission. The upper limits permit the exclusion of coronal temperatures between 50,000^{0}K and 250,000^{0}K. (Diss. Abstr. Int., B)

3751 WAVELENGTH DEPENDENCE OF POLARIZATION. XXIX. Observations of Red Variable Stars. Shawl, S. J. (Univ. of Kansas, Lawrence). Astron. J.; 80: No. 8, 602-624(Aug 1975).

New polarimetric data are presented for 25 stars. Results of comparison between observations and theoretical models of circumstellar clouds are presented. Out of 29 stars that have data good enough to compare with theory, only three are not able to have their observations fitted with either silicate, graphite, or iron grains. The particle sizes are found to be confined to a narrow range of sizes, from Rayleigh particles (radii less than 0.05 mu m) up to a maximum of 0.10 mu m; the average particle size for silicate cloud models is 0.08 mu m (and slightly smaller for iron and graphite); column densities of 1-100 x 10^{23} cm^{-2} are found. For Mira and V CVn, the polarization increases at the time the hydrogen emission lines become visible. Arguments are presented for the production of a large number of small particles that grow and disperse with each light cycle. Detailed discussions are given for o Ceti, V CVn, g Her, X Her, R Hya, and L_2Pup. Observations of complicated time and wavelength changes in the position angle indicates that multiple polarization components are often present. (19 figures, 5 tables, 57 references) (auth)

3752 ON THE RELATIVE IMPORTANCE OF PHASE AND FREQUENCY INFORMATION IN PULSAR TIMING MEASUREMENTS. Press, W.H. (Joseph Henry Laboratories, Princeton University). Astrophys. J. 200: No. 1, 182-186 (15 Aug 1975).

Over a given time interval, the phase (time of arrival) of pulsar signals and their frequency can be measured independently. In principle there is also independent information in yet higher derivatives. A common observational practice is to throw away all information except phase; this results in some loss of signal-to-noise over what might optimally have been obtained. This paper calculates quantitatively the signal loss, in the case of a particular model: the detection of a small sinusoidal phase modulation in a perfectly periodic pulsar whose signal is degraded by white noise. Although idealized, this model applies quite directly to the study of pulsars in binary systems. The optimal prescription for combining phase and frequency measurements taken at different times is given. A noise analysis indicates that—consistent with observational practice—there is only negligible advantage in keeping frequency and higher derivatives, *if* the signal averaging time is short compared to the period of the phase modulation. If the two times are comparable, however, the extra information becomes worth keeping, by an amount expressible in terms of spherical Bessel functions; correspondingly, when the two times are comparable, it is possible to obtain accurate results with frequency information only, i.e., without matching up pulse numbers between successive observing runs. (auth)

3753 OPTICAL APPEARANCE OF DISTANT OBJECTS TO OBSERVERS NEAR AND INSIDE A SCHWARZSCHILD BLACK HOLE. Cunningham, C.T. (California Institute of Technology, Pasadena, California 91125). Phys. Rev. D 12: No. 2, 323-328 (15 July 1975).

To observers inside and near a Schwarzschild black hole, the external universe appears visually distorted and frequency-shifted due to gravitational focusing, gravitational blue-shifts, Doppler shifts, and aberration. This paper calculates the distortion and frequency shifts as seen by observers who sit at rest in hole's external field, and by observers who fall freely from infinity, through the hole's horizon, and into the singularity at its center. (auth)

3754 MEASUREMENT OF MUON-INDUCED ^{26}Al IN TERRESTRIAL SILICATE ROCK. Hampel, W.; Takagi, J. (Max-Planck-Institut für Kernphysik, Heidelberg, Germany); Sakamoto, K.; Tanaka, S. J. Geophys. Res. 80: No. 26, 3757-3760 (10 Sept 1975).

Cosmic ray muon-induced ^{26}Al was measured in terrestrial silicate rock by low-level $\gamma\gamma$ coincidence spectrometry with improved statistics. A positive result was obtained for the first time. The measured activity of 0.0068 ± 0.0028 dpm ^{26}Al/kg SiO_2 is well reproduced by a theoretical estimate of the production rate at a depth of 5 meters water equivalent underground. The result is discussed with respect to the erosion rate of the geological sample during the last millions of years. (auth)

3755 ENCOUNTERS BETWEEN BINARY AND SINGLE STARS AND THEIR EFFECT ON THE DYNAMICAL EVOLUTION OF STELLAR SYSTEMS. Hills, J.G. (Department of Astronomy, The University of Michigan, Ann Arbor, Michigan 48104). Astron. J. 80: No. 10, 809-825 (Oct 1975).

More than 1.4×10^4 computer-simulated encounters between binaries and field stars have been run for various preencounter relative velocities V_f and impact parameters p. At low values of V_f, the encounter causes the binary orbit to shrink and become more tightly bound with the two more massive of the three stars involved in the encounter remaining in the binary and the third being ejected from the binary at a relatively high velocity. As V_f increases, the amount of orbit shrinking decreases until, for V_f greater than a well-defined velocity V_E, the encounter tends to increase the semimajor axis of the binary and eventually to break it apart. We find that about 10% of the binaries with semimajor axes $a_0 > 10^3$ au have broken apart in the solar neighborhood. In globular clusters almost all primordial binaries with $a_0 > 35$ au have broken apart; this is true for binaries with $a_0 > 100$–1000 au in open clusters and $a_0 > 1$–2 au in galactic nuclei. The breakup of these loosely bound binaries has relatively little effect on the dynamical evolution of the stellar system. However, the shrinking of the more tightly bound binary orbits, which feeds kinetic energy into the cluster, will destroy an open cluster in a few times 10^8 y unless it is either unusually massive or unusually deficient in binaries. While the lifetime of a globular cluster due to this mechanism is about 10^{11} y, it is likely that binary stars limit the maximum density attainable in the nucleus of a globular cluster. The presence of the binaries transforms the familiar instability leading to a rapid shrinking of the core of the cluster and to the buildup of a high-density central cusp into one which causes an accelerated rate of decrease in the semimajor axes of the binaries in the core. Binaries are not likely to have any significant effect on the dynamical evolution of a dense galactic nucleus. (auth)

3756 THE TRIPLE SYSTEM ψ SAGITTARII. Fekel, F.C. (Department of Astronomy, University of Texas at Austin and McDonald Observatory, Austin, Texas). Astron. J. 80: No. 10, 844-851 (Oct 1975).

The visual binary ψ Sagittarii (ADS 12214) is a spectroscopic triple system with orbital periods of 10.78 days and 20.0 y. Masses derived from the parameters of the spectroscopic and visual orbits are 2.7 $M_\odot$ for the visual primary, 2.1 $M_\odot$ for the short-period pair primary, and 1.7 $M_\odot$ for the short-period pair secondary. The distance to the system is 100 pc. The orbital inclination of the close pair is nearly the same numerically as that of the visual orbit. Suggested spectral classifications indicate that all three components have evolved off the main sequence. Mass exchange in the close pair has not yet occurred. The system is compared with several other spectroscopic-visual triples. (auth)

3757 APPLICATIONS OF FOURIER ANALYSIS TO BROADENING OF STELLAR LINE PROFILES. I. THREE Mn STARS. Smith, M.A.; Parsons, S.B. (Department of Astronomy,

University of Texas at Austin). Astrophys. J. Suppl. Ser. 29: No. 289, 341-361 (Aug 1975).

This paper explores a modified form of Gray's technique of determining classical microturbulence (T) by Fourier analysis of line profiles. The technique entails the transformation of the functions defined by absorption-line scans to Fourier power spectra. Our instrumental resolution of 0.05 Å does not reduce the strength in the first sidelobe of the power spectra appreciably. Thus the sidelobe power is suitable as a basic criterion in the comparison of computed and observed line profiles. Our study for three Mn Ap stars shows that the formal errors placed on the solution for T are most sensitive to limited photon statistics, to the choice of whether rotation (V) or macroturbulence (M) is dominant in broadening the line, and to the total amount of this broadening. On the other hand the solution for T is insensitive to the damping parameter, the model atmosphere, and the assumption of LTE. We demonstrate that the Fourier technique provides a more convenient and precisely defined test of the value of T than would be obtained from direct comparison of line profiles. For ιCrB we obtain $T=0\pm 1/4$ if $V=4$ km s^{-1}, or $T=3/4\pm 1/4$ if $M=3$ km s^{-1}. For ν Her and ϕ Her, we find $0 \leqslant T \leqslant 3$, with $V=12$. These results do not contradict the statement that both forms of turbulence may be zero. In themselves they do not exclude atmospheric diffusion as the mechanism responsible for abundance anomalies in Mn stars. An unexpected discovery made in this study is that all three strong lines observed in ιCrB show a depression in their blue wings displaced in velocity -9 ± 1 km s^{-1} from the centers. This effect is not instrumental, and it appears unlikely to be caused by a secondary star. The implication is that some hitherto unsuspected mass motions are occurring at the top of the atmospheres or over a small area of these stars. However, it is not yet clear how any such effect can be reconciled with the solutions obtained for low or zero turbulences in the line-formation regions of the atmospheres. (auth)

3758 NEUTRINO PAIR BREMSSTRAHLUNG BY NUCLEONS IN NEUTRON-STAR MATTER. Flowers, E.G. (Department of Physics, New York University, New York, New York 10003); Sutherland, P.G.; Bond, J.R. Phys. Rev. D 12: No. 2, 315-318 (15 July 1975).

We calculate neutrino pair bremsstrahlung from nucleons in neutron-star matter via weak neutral currents. We find bremsstrahlung in neutron-neutron collisions to be unimportant, but find that the bremsstrahlung emissivity in neutron-proton collisions is of the same order as that for the modified URCA process. (auth)

3759 MAGNETIC VISCOSITY IN RELATIVISTIC ACCRETION DISKS. Eardley, D.M. (Physics Department, Yale University); Lightman, A.P. Astrophys. J. 200: No. 1, 187-203 (15 Aug 1975).

We formulate a detailed, self-consistent model of magnetic viscosity in an accretion disk around a rotating, Kerr black hole, in order to help clarify the nature of viscosity in the theory of accretion disks. The magnetic field is amplified by shear and dissipated by reconnection; in steady state a stable balance occurs, leading to a chaotic field configuration consisting of magnetic cells that reconnect with each other about once per orbit. We give detailed models of stationary disks based on the viscosity of this field. The observable properties of these models are similar to those of previous models based on less detailed models of viscosity. We include the relativistic equations governing the time-evolution of an accretion disk around a Kerr black hole, and some criteria for the existence of a radiation-pressure-dominated region or an optically thin region in a stationary disk. (auth)

3760 SUPERNOVAE IN BINARY SYSTEMS. Wheeler, J.C.; Lecar, M.; McKee, C.F. (Center for Astrophysics, Harvard College Observatory). Astrophys. J. 200: No. 1, 145-157 (15 Aug 1975).

The general problem of a supernova explosion in a binary star system is studied. We show that to a good approximation the effect of the impinging blast wave which strips and ablates mass from the companion can be expressed in terms of a single parameter. The eccentricity imparted to the system and the ratio of final to initial semimajor axes depend on two to six parameters, depending on the level of approximation. Results for calculations of the eccentricity imparted to an initially circular system are presented by means of graphs, tables, and simple fitting formulae for two basis types of models; one in which the companion is a "normal" star (polytrope, $n=3$) and one in which the companion is in a "red-giant" phase. We conclude that neutron stars can be formed in close binary systems but that the resulting orbit must have a finite eccentricity. The relevance of this result to X-ray binary systems is discussed. (auth)

3761 THE SOFT X—RAY SPECTRA OF CASSIOPEIA A AND TYCHO'S SUPERNOVA REMNANT. Hill, R.W.; Burginyon, G.A.; Seward, F.D. (Lawrence Livermore Laboratory, University of California, Livermore). Astrophys. J. 200: No. 1, 158-162 (15 Aug 1975).

The x-ray spectra of Tycho's supernova remnant and Cas A have been measured with good statistics. Both spectra show evidence for silicon line emission. The thermal model of Tucker and Koren has been used to fit both spectra. To obtain a satisfactory fit to the data with this model, the silicon abundance must be increased about 10 times from the usual cosmic abundance values. Neither spectrum can be fitted with exponential or power-law models without the addition of line emission. Tycho's remnant shows very little soft X-ray absorption. (auth)

3762 ANALYSIS OF X—RAY SPECTRA REVEALS POSSIBILITY OF ENHANCED SILICON IN THREE SUPERNOVA REMNANTS. Burginyon, G.A.; Hill, R.W.; Seward, F.D. (Lawrence Livermore Laboratory, University of California, Livermore). Astrophys. J. 200: No. 1, 163-170 (15 Aug 1975).

New calculations by Tucker and Koren for X-radiation from a thin hot plasma are applied to observed X-ray spectra of the Cygnus Loop, Vela X, and Puppis A. These calculations cannot satisfactorily describe the spectra of these three old supernova remnants when evaluated at one temperature and for commonly accepted cosmic abundances. However, all of the data are fitted when just two abundance values are changed: an increase in silicon by a factor of approximately 10, and a factor of 5 less iron. This modified set of abundances substituted into Tucker and Koren's model agrees with recent optical coronal line observations in the Cygnus Loop and explains spectra from recent observations of the supernova remnants Cas A and Tycho. It is remarkable that this thermal model with modified abundances fits the spectra of all these objects. (auth)

3763 THE ABSOLUTE MAGNITUDES OF CARBON STARS: CARBON STARS IN BINARY SYSTEMS. Olson, B.I.; Richer, H.B. (Department of Geophysics and Astronomy, University of British Columbia). Astrophys. J. 200: No. 1, 88-94 (15 Aug 1975).

Absolute visual magnitudes have been determined for carbon stars belonging to binary systems. These range from about 0 to brighter than -4, with a mean value of -2.3 for N stars. Bolometric corrections are deduced, giving bolometric absolute magnitudes in the range -4 to -8. (auth)

3764 SEARCH FOR POLARIMETRIC VARIATIONS IN THE CLOSE BINARY GK CEPHEI. Lester, D.F.; Woods, N.E.; Kemp, J.C.; Nolt, I.G. (Department of Physics, University of Oregon, Eugene). Astrophys. J. 200: No. 1, 95-97 (15 Aug 1975).

Polarimetric observations are presented of the close binary system GK Cephei. Based on 27 nights of observations, in the B filter, we set an upper limit to such effects in GK CEP of $\Delta p=0.015$ percent, with a phase resolution of 0.10. The interstellar polarization was measured very accurately as $p=0.20\pm 0.02$ percent, $\theta=71°\pm 1°$, in the blue. (auth)

3765 EPSILON CORONAE AUSTRINAE: EVIDENCE FOR BINARY STAR EVOLUTION? Tapia, S. (Steward Observatory, University of Arizona); Whelan, J. Astrophys. J. 200: No. 1, 98-105 (15 Aug 1975).

Spectroscopic radial velocity observations of ϵ Coronae Austrinae, the brightest W UMa type contact binary system, are reported. The parameters (masses, radii, luminosities) of the components of the system have been determined. The primary, of mass about $1.5\,M_\odot$, is probably evolved and burning hydrogen in its core. The secondary has a very low mass near $0.15\,M_\odot$. It may be unevolved and deriving most of its luminosity from energy transfer from the primary; or it may be significantly evolved and burning hydrogen in a shell, with the present mass exchange the second one. Difficulties with the solution and possible evidence for gas streaming, mass loss, and angular momentum loss from the system are discussed. (auth)

3766 *MARINER* 9 ULTRAVIOLET SPECTROMETER EXPERIMENT: STRONG STELLAR LINES IN OB STARS. Molnar, M.R. (Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder). Astrophys. J. 200: No. 1, 106-112 (15 Aug 1975).

Data from the ultraviolet spectrometer on the *Mariner* 9 Mars orbiter have been used to measure the strong stellar lines of Si III λ 1300, Si IV λ 1400, and C IV λ 1550. The C IV equivalent widths appear to be in good agreement with preliminary OAO-2 results; however, the *Mariner* 9 Si IV equivalent widths for B1 stars appear to be smaller by a factor of ~0.7. We have also made LTE calculations for the equivalent widths of these Si III and Si IV lines. Significant differences are found between various theoretical investigations which can be attributed to different models and, in particular, f-values. The observations are compared with the theoretical results. We suspect that line-blending effects make any interpretation uncertain. (auth)

3767 PHOTOMETRY OF O-TYPE STARS, INTERPRETED WITH REFERENCE TO MODEL ATMOSPHERES. Morrison, N.D. (Institute for Astronomy, University of Hawaii). Astrophys. J. 200: No. 1, 113-121 (15 Aug 1975).

Strömgren-system colors for O-type stars have been compared with colors calculated by Mihalas from non-LTE model atmospheres and by Mihalas and Hummer from models with extended geometry. Within the accuracy of the observations, effective temperatures derived from the photometry for main-sequence stars agree with those derived by Conti from a ratio of intensities of spectral lines; consistency of the calculated colors with the calculated strengths of the lines is demonstrated for the

non-LTE plane-parallel models. For Of stars of luminosity classes III and I, and O stars of luminosity class I, c_1 is consistently more negative than it is for main-sequence stars by an amount that is consistent with the predictions of the models with extended geometry. For stars earlier than type O6, c_1 is consistently more positive than the plane parallel models predict, and possible reasons for this effect are discussed. (auth)

3768 THE BINARY NATURE OF THE STAR HD 108. Hutchings, J.B. (Dominion Astrophysical Observatory, Victoria, B.C.). Astrophys. J. 200: No. 1, 122-127 (15 Aug 1975).

The peculiar Of star HD 108 is found to vary in velocity with a period of 4.612 days. The star is considered to be a binary with a companion of mass $\lesssim 2.5\,M_\odot$, which *may* be a collapsed object. The primary has a high-density stellar wind which is partially affected by its companion. Emission lines from the extended envelope show phase-correlated velocity variations, but no marked intensity variations. Comparisons are made with the similar Of binaries HD 153919 and 148937. (auth)

3769 SHORT-TERM VARIABILITY OF γ^2 VELORUM. Bahng, J.D.R. (Astronomy Department, Northwestern University). Astrophys. J. 200: No. 1, 128-132 (15 Aug 1975).

Photoelectric spectrum scans of γ^2 Velorum in the spectra range 4600-4720 Å were analyzed to study the short-term variability of brightness and of emission line strengths. The emission strengths of He II λ 4686 and C III-IV λ 4650 show rms variations of 3 and 2 percent, respectively. These variations have time scales of 1 minute and longer. Night-to-night variations were also found. The continuum radiation also shows small-amplitude variations. No periodic variations attributable to this star were detected on any of the nights on which these observations were made. (auth)

3770 ON PROTOSTELLAR EVOLUTION. Westbrook, C.K. (Department of Applied Science, University of California, Davis); Tarter, C.B. · Astrophys. J. 200: No. 1, 48-60 (15 Aug 1975).

An investigation of the evolution of spherically symmetric protostars with initial masses in the range $0.1 \leqslant M/M_\odot \leqslant 50$ has been carried out. In order to perform the calculations, a numerical technique has been developed in which rapid dynamical motions in one region of the star and quasi-static evolution in another region can be simultaneously computed. The general evolutionary features are similar to those found by other workers: an initial free-fall collapse is followed by the creation of a core in hydrostatic equilibrium, and the core's subsequent accretion of the surrounding envelope. However, our final hydrostatic-equilibrium configurations have radii large compared with those of the protostellar models of Larson (but in reasonable agreement with those of conventional pre-main-sequence models). For low-mass protostars ($M \leqslant M_\odot$) the luminosity remains relatively small until late evolutionary times and the evolution is very sensitive to the treatment of convective energy transport. For large-mass protostats ($M \geqslant 3M_\odot$) a convective phase never exists, and a fraction (increasing with mass) of the initial mass is ejected by the combined effects of heating and radiation pressure in the envelope. We present detailed numerical results for the evolution of a $1\,M_\odot$ protostar, a summary of the results for other protostellar masses, and a discussion of some observational implications of the work. (auth)

3771 LUNAR OCCULTATIONS OF BETA SCORPII IN 1975 AND 1976. Van Flandern, T.C.; Espenschied, P. (U.S. Naval Observatory). Astrophys. J. 200: No. 1, 61-67 (15 Aug 1975).

The complex multiple star β Scorpii (combined magnitude 2.5) will be occulted by the Moon 19 times during 1975-1976. Limiting lines of visibility for these occultations are presented in two maps. From modern observations it is apparent that β Sco is at least quadruple, but there is evidence for the existence of three additional components. The 1971 May occultation of the β Sco system by Jupiter and of its C component by Io raised important questions about β Sco and about Jupiter and Io, making the coming occultation series especially significant. With high-time-resolution photoelectric photometry, it is likely that definitive knowledge of the system's structure can be obtained during the coming series. Detailed predictions of local circumstances are available from the authors. (auth)

3772 METAL ABUNDANCES FOR RR LYRAE STARS IN GALACTIC GLOBULAR CLUSTERS. Butler, D. (Lick Observatory, Board of Studies in Astronomy and Astrophysics, University of California, Santa Cruz). Astrophys. J. 200: No. 1, 68-81 (15 Aug 1975).

Image-tube scanner measurements of Preston's metal abundance indicator, ΔS, have been made for 47 RR Lyrae stars in 12 galactic globular clusters, and for 67 field RR Lyrae stars. Another index, ΔS (G), which is a measure of metallic-line absorption in the region of the G-band, has also been determined. From curve-of-growth analyses of 13 field RR Lyraes, the relationship $[Fe/H] = -0.16\Delta S - 0.23$ is found, where $[Fe/H] = \log(Fe/H)_* - \log(Fe/H)_\odot$. A comparison of the ΔS versus ΔS (G) relationships derived for field and cluster RR Lyraes indicates that the same calibration applies to both groups. The calibration is then used to deduce values of [Fe/H] for the globular cluster RR Lyraes, and hence the globular clusters themselves. We find metal abundances ranging from [Fe/H]=0.39 for NGC 6712 to [Fe/H]=−2.18 for M92. (auth)

3773 HIGH-SPEED SPECTROSCOPY OF THE ULTRASHORT-PERIOD VARIABLE AM CANUM VENATICORUM (=HZ 29). Robinson, E.L.; Faulkner, J. (Lick Observatory, Board of Studies in Astronomy and Astrophysics, University of California, Santa Cruz, CA 95064). Astrophys. J. Lett. 200: No. 1, L23-L25 (15 Aug 1975).

The ultrashort period variable AM CVn possesses a most unusual spectrum which may support an interpretation of the object as an accreting, semidetached binary white dwarf system. (auth)

3774 ULTRAVIOLET OBSERVATIONS OF ALPHA AURIGAE FROM *COPERNICUS*. Dupree, A.K. (Center for Astrophysics, Harvard College Observatory and Smithsonian Astrophysical Observatory). Astrophys. J. Lett. 200: No. 1, L27-L31 (15 Aug 1975).

Emission lines of Lα (1215.67 Å) and O VI (1031.94 Å) were detected in the spectroscopic binary α Aur (Capella) with the Princeton experiment on *Copernicus*. Temperatures of the emitting regions are inferred to be in excess of 3×10^5 K. The temperature and emission measure are consistent with a variable source of soft x rays. If the emission is attributed to the primary star (G5 III), the atmosphere is expanding with velocities ~ 20 to 100 km s^{-1}. Such expansion can lead to material within the binary system. The density of interstellar hydrogen inferred from absorption of stellar Lα appears to be ~ 0.01 hydrogen atoms cm^{-3}. (auth)

3775 CONTINUOUS ULTRAVIOLET ABSORPTION INTO DOUBLE-EXCITED STATES OF H^-. Jacobs, V.L.; Bhatia, A.K.; Temkin, A. (Theoretical Studies Group, Goddard Space Flight Center, National Aeronautics and Space Administration, Greenbelt, Maryland). Astrophys. J. 200: No. 1, 239-243 (15 Aug 1975).

The absorption coefficient for the transitions $H(1s)+e^-+h\omega \rightarrow H^{-**} \rightarrow H(1s)+e^-$ is calculated using Q-projected Hylleraas wave functions for the lowest-lying autodetaching resonances (H^{-**}) of H^- and 1s-2s-2p close-coupling initial-state continuum wave functions. For electron temperatures below 5000 K, absorption into the $2s2p\ ^3P$ state of H^- prevails over the absorption arising from the linear-Stark broadening of Lα by electrons in the wavelength region 1275–1340 Å. (auth)

3776 RADIO STRUCTURE OF 3 C 358, THE REMNANT OF KEPLER'S SUPERNOVA. Strom, R. G. (Huygens Laboratorium, Leiden); Sutton, J. Astron. Astrophys.; 42: No. 2, 299–302(Aug 1975).

21 cm synthesis observations of 3 C 358 show the remnant to be a slightly elliptical object, roughly 3′.2 x 4′.2 in size with the major axis north-south. The eastern, western and southern edges are sharp while to the north the emission dies away more gradually. There is no clear indication of shell structure. The source is linearly polarized, typically by 3%. 3 C 358 is compared briefly with the remnant of Tycho's supernova and it is shown that despite their dissimilar structures, in terms of energy content and other physical parameters the two objects are nearly alike. (auth)

3777 SEARCH FOR OPTICAL PULSATIONS FROM SINGLE LINE SPECTROSCOPIC BINARIES. Nevo, I.; Sadeh, D., Frohlich, A. (Tel-Aviv Univ., Israel). Astron. Astrophys.; 42: No. 2, 247-250(Aug 1975).

Optical power spectra has been obtained from 16 single line binaries that are suspected of harbouring a neutron star or a black hole. The spectra were scanned for both narrow and wide band features. No significant pulsation was detected. (auth)

3778 NEW CALCULATIONS OF ATOMIC DATA CONCERNING E.U.V. LINES OF O V. Malinovsky, M. Laboratoire de Physique Stellaire et Planetaire, Verrieres le Buisson, France). Astron. Astrophys.; 43: No. 1, 101-110(Sep 1975).

New values of transition probabilities and cross sections are given for O v. They are calculated in a coherent way: firstly, atomic wave functions are calculated in a Thomas Fermi potential; spin orbit and electrostatic configuration interaction is taken into account. Nine configurations are included. Atomic probabilities transitions follow. Secondly, the preceding wave functions are used to calculate the electron collision strengths with the distorted wave approximation, and the proton collision strengths with a semi classical approximation. Equations of statistical equilibrium are solved from which theoretical variation of line ratios with electron density N_e and electron temperature T_e are deduced. Resonances in the fine structure collision strengths between the levels of the $2s2p^3P$ term are shown to be of a drastical importance. Values of electron density N_e, and electron temperature T_e, are then deduced from appropriate U. V. observed line ratios. The sensitivity of these physical parameters (N_e, T_e) to the remaining uncertainties in atomic data is discussed. (auth)

3779 DETAILED ANALYSIS OF THE HIGH-VELOCITY GIANT HD 6497. Cayrel de Strobel, G. (Observatoire de Meudon, France); Pasinetti, L. E. Astron. Astrophys.; 43: No. 1, 127-131(Sep 1975).

This new detailed analysis of the high-velocity giant HD 6497 (K2 III) shows the importance of using really weak lines in abundance determinations. The present analysis has been performed from curves of growth enriched in weak-lines. HD 6497 is found normal in iron-content in contrast of some previous determinations. This finding raises questions regarding the star's membership in the Arcturus moving group. (auth)

3780 INTERSTELLAR REDDENING AND IR-EXCESS OF O AND B STARS. Schultz, G. V. (Max-Planck-Institut fuer Radioastronomie, Bonn); Wiemer, W. Astron. Astrophys.; 43: No. 1, 133-139(Sep 1975).

350 O and B stars were selected according to specific criteria. Two-color diagrams were used to derive a mean law of interstellar reddening for the various directions of our galaxy included in this study. The reddening constant was derived to be $R = A_v/E_{b-v} = 3.14 \pm 0.10$. Only 20 out of 350 stars were found above the determined upper scattering limit, and therefore show an apparent infrared excess. We conclude from our investigation that we are able to distinguish between normally reddened O and B stars and stars which show anomalous infrared excess. (auth)

3781 OBSERVATIONAL PROPERTIES OF MODELS OF SEMIDETACHED CLOSE BINARIES. II. Giannone, P. (Univ., Rome); Giannuzzi, M. A.; Pucillo, M. Astron. Astrophys.; 43: No. 1, 141-148(Sep 1975).

Observational properties and the probability of discovery as eclipsing binaries have been determined for models of semidetached systems. Binaries of Cases A and B with intermediate and small masses have been studied. Synthetic light curves are shown to be affected mainly by the assumption concerning the shape of the components. The comparison between synthetic light curves and observed data can give further information on the reliability of the hypotheses assumed in the computations of binary star evolution. The calculated properties lead to useful indications about the evolutionary stages of observed binaries. The detection of systems evolving according to Case A appears to be favoured in comparison with that of systems of Case B. Systems with undersize subgiants result comparatively difficult to observe. (auth)

3782 OBSERVATIONS OF THE DIFFUSE LAMBDA 4430 ABSORPTION BAND IN SOUTHERN O, B, AND A STARS. Gammelgaard, P. (Univ. of Aarhus, Denmark). Astron. Astrophys.; 43: No. 1, 85-92(Sep 1975).

Photoelectric narrow-band observations of the intensity of the diffuse interstellar λ 4430 absorption band have been carried out for 65 southern A, B, and A stars of luminosity classes I and II. The galactic longitudes of the stars are in the interval $184° < l^{II} < 53°$. The dependence of the λ 4430 index on stellar spectral lines is eliminated and the variation of the ratio J_c/E_{b-v} of λ 4430 to selective absorption from place to place in the Galaxy is discussed. It is found that J_c/E_{b-v} is significantly lower in the inter-arm region than inside the inner and outer spiral arms. The observed value of J_c/E_{b-v} for HD 153919, the optical component of the binary system containing x-ray source 2 U 1700-37, indicates a distance of at least 1.5 kpc which suggests that it is more luminous and massive than an ordinary O 6 star. (auth)

3783 STELLAR EVOLUTION. IV. Evolution of a Star of 1.5 Msub Solar from the Main-Sequence to the Red-Giant Branch with and without Overshooting from Convective Core. Maeder, A. (Observatoire de Geneva). Astron. Astrophys.; 43: No. 1, 61-69(Sep 1975).

For a star of $1.5M_\odot$ with an initial composition given by X = 0.70 and Z = 0.03, three sets of evolutionary models are computed with different assumptions on the non-local effects characterizing the turbulent motions in the convective core. Some overshooting from the convective core may occur during Main-sequence evolution. The changes in the stellar structure, lifetimes and evolutionary tracks brought about by this process are studied. Some characteristics of the evolutionary tracks in the theoretical HR diagram have a very high sensitivity to the exact extent of the convective core, and this may provide powerful tests of events occurring in the deep stellar interior. Some comparisons between models and observational results are attempted; they suggest the rejection of the models with large overshooting (5% of the total mass or more at $1.5M_\odot$), while moderate overshooting (2-3% of the total mass) tends to be supported. Some comments are made on the estimates of helium and metal abundances derived from features of cluster sequences. (auth)

3784 NON-UNIFORM EXTINCTION IN OPEN STAR CLUSTERS AND DISPERSION OF THE PHOTOMETRIC SEQUENCES. Burki, G. (Observatoire de Geneva). Astron. Astrophys.; 43: No. 1, 37-44(Sep 1975).

The importance of non-uniform extinction in open star clusters of intermediate age is studied on the basis of photoelectric UBV measurements in open clusters catalogued by Mermilliod (1975) and of Wallenquist's study (1975) of the presence of absorbing matter by star counts in the fields of open clusters. It is found that clusters having less uniform projected stellar density on the sky are also those which present the largest dispersion in the two color diagram. The major causes of dispersion in the photometric sequences are discussed and it is shown that the differential extinction is important not only in the case of very young clusters, but also in some clusters older than $5 \cdot 10^7$ years. The effects of stellar rotation, stellar duplicity, and the limited precision of the measures can explain the observed dispersion in the least reddened clusters, and are in total agreement with the thickness of the main sequence in the two colour UBV diagram found by Jaschek and Jaschek (1973) on the basis of unreddened BV and AV field stars. (auth)

3785 PHYSICAL LIMITS TO ATTAINABLE ACCURACIES IN STELLAR RADIAL VELOCITIES. Dravins, D. (Lund Observatory, Sweden). Astron. Astrophys.; 43: No. 1, 45-50(Sep 1975).

Although recent instrumental developments allow the determination of radial velocities of stellar spectral lines with a precision of 0.1 km/s, it is not possible to obtain the true stellar radial velocity to better than ≈0.5 km/s unless one has detailed knowledge of the small-scale inhomogeneities in the region of line formation. Especially convection cell velocity patterns cause line asymmetries and average wavelength shifts that depend critically on many unknown parameters and are likely to vary from star to star. More accurate velocities might be obtained from strong lines formed sufficiently high in the atmosphere to (hopefully) be above the convective region. The best candidate is the Na I D_1 line, although it may be contaminated by chromospheric emission and circum- or interstellar absorption. (auth)

3786 THREE-BODY PROBLEM AND ECLIPSING BINARIES. Application to Algol and Lambda Tauri. Soederhjelm, S. (Lund Observatory, Sweden). Astron. Astrophys.; 42: No. 2, 229-236 (Aug 1975).

The gravitational perturbations in triple star systems are studied by well-known approximate methods. The major field of application is for a close eclipsing pair with nearly circular orbit, attended by a not too distant companion. (Period in outer orbit less than some 100 times the close one.) Formulae are derived for the "long-period" perturbations, with periods of the same order as that in the outer orbit, and for the secular motions of the apse and node. The usually quoted formulae for these latter motions are shown to be valid only for a very massive or distant third body; for λ Tau, where the companion is close and of low mass, the nodal motion is more than twice as fast. For an eclipsing system, nodal motion is bound to produce changes in the eclipse depths, unless the orbits are exactly co-planar. In this way upper limits of 11° and 7° respectively are derived for the relative inclinations of the orbits in Algol and λ Tau. (auth)

3787 INTERACTION OF HOT STARS AND OF THE INTERSTELLAR MEDIUM. VII. The Rate and Fate of Stellar Ultraviolet Photons. Georgelin, Y. M.; Lortet-Zuckermann, M. C.; Monnet, G. (Observatoire de Marseille, France). Astron. Astrophys.; 42: No. 2, 273-285(Aug 1975).

The new set of observational data gathered by Y. M. Georgelin (1975) on exciting stars of galactic nebulae is used to reanalyze the calibration of spectral-type into effective-temperature. The available model-atmospheres which appear to be the closest to an ideal blanketed NLTE spherical model, as discussed by Panagia (1973) are used, and a sample of nebulae best fitted for the use of the Zanstra method. An empirical calibration of $N_L/\pi F_V$ (the ratio of the ionizing photons flux to the energy emitted in the photometric V-band) is obtained as a function of the spectral Mk types in the range O 6-B0, and then the total photon luminosity and excitation-parameter. The ratio $N_L/\pi F_V$ rather than an absolute flux (like L_{UV}(photons s^{-1}) or $u \sim L_{UV}^{\frac{1}{3}}$) is used to describe the excitation of the nebula, because this ratio is quite insensitive to gravity, model-atmosphere, absolute magnitude scale and distance. (auth)

3788 SPECTRUM OF THE BRIGHT VARIABLE A-1 IN M 31. Bianchini, A.; Rosino, L. (Astrophysical Observatory, Asiago, Italy). Astron. Astrophys.; 42: No. 2, 289-291(Aug 1975).

The spectrum of the bright variable A-1 in M 31 recently obtained at Asiago with the 182 cm telescope is described. The remarkable similarity of this star to η Car is pointed out. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstracts 3728, 3744, 3745, 3782, 3835, and 3858.

3789 (N-75-12863) NEW MEASUREMENT OF THE Her X-1 x-RAY PULSE PROFILE. Holt, S. S.; Boldt, E. A.; Rothschild, R. E.; Serlemitsos, P. J. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Jan 1974. 11p. (NASA-TM-X-70578; X-661-74-11). NTIS $3.25.

A triple peaked 1.24 sec pulse profile in a 1-minute rocket borne exposure to Her X-1 was measured, in contrast to the doublepeaked profiles expected from models which maximize the X ray emission at the magnetic equator of an accreting neutron star. The profile exhibits statistically significant energy dependence, with the emission approximately greater than 12 keV having narrower peaks which lag (by approximately 5 percent of the pulse period) the corresponding peaks at lower energies. Approximately one-third of the total emission from the source is nonpulsed. (auth)

3790 (N-75-12887) INTERSTELLAR SCATTERING OF PULSAR RADIATION. 1. Scintillation. Backer, D. C. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Nov 1974. 31p. (NASA-TM-X-70789; X-693-74-316). NTIS $3.75.

An investigation of the intensity fluctuations of 28 pulsars near 0.4 GHz indicates that scintillation spectra have a Gaussian shape, scintillation indices are near unity, and the scintillation bandwidth depends linearly on dispersion measure. Observations near 2.5 GHz suggest a strong dependence of the frequency at which scintillation indices fall below unity on dispersion measure. Multistation measurements of scintillation provide values or limits for the scale size of the scattering diffraction pattern. The dependences of scattering parameters on dispersion measure is discussed in terms of the current models. It is suggested that any line of sight through the galaxy encounters increasingly rare, increasingly large deviations of thermal electron density on the scale of 10 to the 11th power cm. (auth)

3791 (N-75-21204) DETAILED STUDIES OF THE NON-PERIODIC TIME VARIABILITY OF SEVERAL GALACTIC X-RAY SOURCES. Final Report, 1 November 1973–31 March 1975. Weisskopf, M. C. (Columbia Univ., New York (USA). Columbia Astrophysics Lab.). Apr 1975. 32p. (NASA-CR-142551; CAL-1291). NTIS $3.75.

Computer software necessary for the analysis of the time variability of x-ray sources was developed and tested. Seventy-one Uhuru observations of the black hole candidate Cygnus X-1 were also examined. Data show that the x-ray emission can be best represented as arising from randomly occurring x-ray flares with a mean rate of occurrence of 18 flares/sec and a mean cooling time of approximately 1/2 sec. Furthermore data show that photons in the 2 to 16 keV bandwidth arise from within the same flares. Finally, it was found that the mean flare rate and cooling time have been constant since the source underwent a spectral transition in March 1971. Long term variations of several parameters associated with the x-ray emission from this object were studied. (auth)

3792 COMPARISON BETWEEN TWO ABNORMAL REDSHIFTS OBSERVED NEAR THE SOLAR DISC. Depaquit, S.; Pecker, J. C. (Centre National de la Recherche Scientifique, 75 - Paris (France). Inst. d'Astrophysique); Vigier, J.-P. (Paris-6 Univ., 75 (France). Inst. Henri Poincare). C. R. Hebd. Seances Acad. Sci., Ser. A, B; 279: No. 23, 559-563(2 Dec 1974). (In French)

Abnormal redshifts observed by Sadeh et coll on the Taurus A radiosource (at λ = 21 cm in absorption), and by Goldstein on the ν = 2292 MHz frequency line emitted by the Pioneer-6 satellite are compared. It seems that a new kind of interaction is involved between the incident photons observed and very light particles emitted at the surface of the sun. (FR)

3793 COMPARISON OF TWO ANOMALOUS REDSHIFTS OBSERVED IN THE CLOSE VICINITY OF THE SOLAR LIMB. Depaquit, Serge; Pecker, J. C. (Centre National de la Recherche Scientifique, 75 - Paris (France). Inst. d'Astrophysique); Vigier, J.-P. (Paris-6 Univ., 75 (France). Inst. Henri Poincare). C. R. Hebd. Seances Acad. Sci., Ser. A, B; 280: No. 5, 113-114(3 Feb 1975). (In French)

The observations of W 28 S at 18 cm do not contradict previous data observed at 21 cm (Tau A), and the existence of an abnormal redshift for sources eclipsed by the sun, during such an eclipse. (FR)

3794 AN ANOMALY IN THE FLUX OF CASSIOPEIA A AT 38 MHz. Erickson, W.C.; Perley, R.A. (Clark Lake Radio Observatory, Astronomy Program, University of Maryland). Astrophys. J. Lett. 200: No. 2, L83-L87 (1 Sept 1975).

The secular decrease in the flux of the supernova remnant Cassiopeia A has been measured at many radio frequencies. We present new observations that indicate that this flux decrease has halted at 38 MHz, and that the flux is increasing at this frequency. This may indicate that a new era of activity has begun in this object. (auth)

3795 PHOTOMETRIC HISTORIES OF QSOs: 3C 279, THE MOST VARIABLE AND POSSIBLY MOST LUMINOUS QSO YET STUDIED. Eachus, L.J.; Liller, W. (Center for Astrophysics, Harvard College Observatory and Smithsonian Astrophysical Observatory). Astrophys. J. Lett. 200: No. 2, L61-L62 (1 Sept 1975).

3C 279, a QSO with a red shift $z = 0.536$, reached a B magnitude of 11.27 ± 0.07 in 1937 April, and several times has become brighter than $B = 13.0$. We calculate that at its brightest, the absolute magnitude of 3C 279 was −31.4 making it optically one of the most luminous known objects to occur in the universe, assuming its redshift is cosmological. With a minimum brightness recorded by Sandage *et al.* at $B = 18.0$, 3C 279 exhibits a range of ≥ 6.7 mag, and thus becomes the most variable QSO or BL Lacertae object yet studied. Its light curve suggests a tendency to repeat outbursts at ~7 year intervals. (auth)

3796 INFLUENCE OF THE INTERSTELLAR MEDIUM ON OBSERVED DIMENSIONS OF RADIO SOURCES. Lotova, N. A.; Pynzar, A. V. (Lebedev Inst. of Physics, Moscow). Izv. Vyssh. Uchebn. Zaved., Radiofiz.; 18: No. 7, 919-925(1975). (In Russian)

A comparative analysis of the influence of interplanetary and interstellar medium on the observed quasar dimensions at the meter wavelengths is given. It is shown that these dimensions are defined only by the interstellar medium. This fact permits the use of quasars for studying the ionized gas distribution in Galaxy according to the measured dimensions of quasars. (auth)

3797 A SEARCH FOR OPTICAL PULSATIONS FROM X—RAY SOURCES NEAR λλ4640–4650 AND λ4686. Canizares, C.R.; McClintock, J.E. (Department of Physics and Center for Space Research, Massachusetts Institute of Technology). Astrophys. J. 200: No. 1, 177-181 (15 Aug 1975).

We have searched for periodic optical pulsations from Cyg X-1, Cyg X-2, 3U 1700–37, Her X-1, Sco X-1, Vela X-1, SMC X-1, WRA 977, and from the central region of the Cygnus Loop. Most observations were confined to the spectral features around λλ4640–4650 and λ4686, which are seen in most X-ray source counterparts, are known to be variable, and are likely to be associated with the X-ray emission. No optical pulsations were detected, but upper limits are established and related to the X-ray behavior. (auth)

3798 OPTICAL STUDIES OF *UHURU* SOURCES. XII. THE LIGHT CURVE OF SCORPIUS X-1 = V818 SCORPII, 1889–1974. Wright, E.L.; Gottlieb, E.W.; Liller, W. (Center for Astrophysics, Harvard College Observatory and Smithsonian Astrophysical Observatory). Astrophys. J. 200: No. 1, 171-176 (15 Aug 1975).

An analysis of 1068 photographic observations of V818 Sco = Sco X-1 from the Harvard plate collection, as well as 698 post discovery magnitudes, shows that its B magnitude ranges between 11.8 and 13.7. However, there is strong evidence that Sco X-1 has been systematically fainter by 0.3–0.4 mag since the mid-1960s. All the available magnitudes have been combined to give an improved mean light curve at the $0^d.787313$ period derived by Gottlieb, Wright, and Liller. The double period light curve, folded at $1^d.574626$, is also given and discussed. The radial velocity curve, based on published data, and the variations in color make it possible to draw new conclusions on plausible models for Sco X-1. These are described, and we conclude by making recommendations for further observations. (auth)

3799 SPECTROSCOPIC OBSERVATIONS OF THE X—RAY BINARY HD 153919 = 3U 1700–37. Conti, P.S. (Joint Institute for Laboratory Astrophysics, University of Colorado); Cowley, A.P. Astrophys. J. 200: No. 1, 133-144 (15 Aug 1975).

Radial velocities, equivalent widths, and line profiles, with emphasis on the lines in the visual region, are discussed for the Of star HD 153919, associated with the binary X-ray source 3U 1700–37. Most absorption and emission lines show little, if any, variation with phase. However, the He I λ 5876 line shows marked changes in the absorption profiles, which are strongly phase-dependent and can be interpreted as indicating a trailing "wake" behind the X-ray source. The C IV absorption lines at λλ5801, 5812 show an anomalous velocity. Hα and the C III λ5696 emission lines are found to be variable in intensity, but the changes are only weakly phase-dependent. The behavior of these four lines suggests long-term variations in the expanding envelope surrounding the Of star, and indicates a nonuniform mass loss rate. It appears likely that even the other absorption lines are formed in a region of the star moving outward at an already appreciable velocity. The star is compared with other extreme Of stars. (auth)

3800 SPLITTINGS IN QUASAR ABSORPTION LINES. Bahcall, J.N. (Institute for Advanced Study, Princeton, New Jersey 08540). Astrophys. J. Lett. 200: No. 1, L1-L3 (15 Aug 1975).

It is shown that the apparent constancy of the splitting between quasar absorption lines observed by Boksenberg and Sargent could be understood if the typical velocity in the absorbing material were somewhat less than the observing resolution (estimated to be 100 km s^{-1}). If this interpretation were correct, then there should be many more redshifts that are split with velocity separations that are less than 100 km s^{-1} than have been so far observed at velocity separations of the order of 150 close to, or very far away from, the quasar. Some results are presented for a specific model in which the splittings are supposed due to absorption in halos or clouds surrounding galaxies or small groups of galaxies and some tests of this model are suggested. The model parameters are consistent with recent radio observations of H I clouds or halos that extend far from their parent galaxies. (auth)

3801 X—RAY EMISSION FROM THE CENTAURUS CLUSTER. Mitchell, R.J.; Charles, P.A.; Culhane, J.L.; Davison, P.J.N. (Mullard Space Science Laboratory, Department of Physics and Astronomy, University College London); Fabian, A.C. Astrophys. J. Lett. 200: No. 1, L5-L8 (15 Aug 1975).

X-ray emission from the Centaurus cluster of galaxies has been studied in the energy range 0.6–7.5 keV using the MSSL X-ray telescopes on the *Copernicus* satellite. Exponential and power-law spectra fit the data equally well. A value of the interstellar column density is found which is in good agreement with radio observations. The X-ray emission detected in the 12° field of view of the *Copernicus* telescope is much greater than would be expected on the basis of the *Uhuru* isothermal gas sphere model. This may indicate either that the size of the extended X-ray source is less than reported by Kellogg and Murray or that the galaxy NGC 4696 is a relatively compact source embedded in the general emission from the cluster. (auth)

3802 THE X—RAY SOURCE MX 0513–40 AND THE GLOBULAR CLUSTER NGC 1851. Vidal, N.V.; Freeman, K.C. (Mount Stromlo and Siding Spring Observatory, Research School of Physical Sciences, Australian National University). Astrophys. J. Lett. 200: No. 1, L9-L11 (15 Aug 1975).

A hot low-gravity "UV-bright" star is found near the edge of the 1 σ error box of MX 0513–40 and about 0'.5 from the nucleus of the globular cluster NGC 1851. Its radial velocity is consistent with cluster membership and may be slightly variable. On some spectra a blueward emission component is found at Hβ. (auth)

3803 CIRCULAR POLARIZATION OF THE X—RAY SOURCES SCORPIUS X-1, CYGNUS X-1, AND 3C 273. Severny, A.B.; Kuvshinov, V.M. (Crimean Astrophysical Observatory, Academy of Sciences of the USSR). Astrophys. J. Lett. 200: No. 1, L13-L17 (15 Aug 1975).

Systematic *B*- and *V*-color observations during 1972–1974 of the circular polarization of Sco X-1 (12 nights), Cyg X-1 (28 nights), and 3C 273 (31 nights) showed the occasional appearance of appreciable and variable polarization. Sixteen control observations of the white dwarf Grw+70°8247 led to values which are in agreement with those previously obtained. (auth)

3804 OPTICAL AND X—RAY OBSERVATIONS OF THE PSR 1913 + 16 FIELD. Davidsen, A.; Margon, B.; Liebert, J.; Spinrad, H.; Middleditch, J.; Chanan, G.; Mason, K.O.; Sanford, P.W. (University of California, Berkeley). Astrophys. J. Lett. 200: No. 1, L19-L21 (15 Aug 1975).

We have obtained medium-resolution spectra in the yellow of seven stars in the error box of the binary radio pulsar PSR 1913+16, using the image-tube scanner at the Lick 3-m telescope. None of the objects is spectroscopically abnormal and thus a strong candidate for membership in the system. The data are used to establish the extinction in the field, which is modest for this low galactic latitude. For three of the stars, limits of order $V > 23$ mag on optical pulsations with the frequency of the radio pulsar are derived. X-ray observations of the field have been obtained in the 2.5–7.5 keV band, using the UCL experiment abroad OAO *Copernicus*. No source is detected, with a 2 σ upper upper limit on the time-averaged flux of 1.0×10^{-10} ergs cm^{-2} s^{-1}. (auth)

3805 INTERPRETATION OF THE MAGNITUDE-REDSHIFT DIAGRAM FOR QUASARS. Evans, A.; Hart, D. (Univ. of Keele, Eng.). Astron. Astrophys.; 43: No. 1, 13-15(Sep 1975).

It is shown that the slope of the magnitude-redshift relationship for cosmologically distant quasars need not have the usual value of 5 mag per decade, provided that the luminosity of an individual quasar decreases over a period $\sim 10^9$ years and the effects of light travel time are taken into account. The possibility of detecting quasars of very high redshift is discussed. (auth)

3806 IDENTIFICATION AND PHOTOMETRY OF RADIO-SOURCES OF THE 3 CR CATALOGUE. III. The Case of the Source 3 C 303. Lelievre, G.; Wlerick, G. (Observatoire de Paris, Meudon, France). Astron. Astrophys.; 42: No. 2, 293-297(Aug 1975). (In French).

Radio observations of Pooley and Henbest (1974) at 5 GHz, show that the source 3 C 303 is double with 19" separation. Using new optical positions it is found on deep electronographic plates that there exists an optical object in coincidence with each radiocomponent. At the position of the preceding one, is a faint object u showing a strong U. V. excess: $V = 21.70$, $B - V = 0.50$, $U - B = -0.90$. Close to u (within 10"), are two other objects with U. V. excesses; the brighter one was already noted by Véron. (auth)

Solar Phenomena

Refer also to abstracts 3745, 3792, 3793, 3876, and 3887.

3807 (LBL--3280) MEASUREMENT OF CIRCUMSOLAR RADIATION. Grether, D.; Nelson, J.; Wahlig, M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1975. 10p. (CONF-750852--1). Dep. NTIS $4.00.

From 19th annual technical symposium of the Society of Photo-Optical Instrumentation Engineers; San Diego, California, USA (18 Aug 1975).

An instrument system has been developed to measure the flux of energy from the sun and the circumsolar region (the small-angle region around the sun) as a function of angle, wavelength, and atmospheric conditions. The measurements are necessary to accurately predict the performance of solar thermal conversion systems using focusing collectors, and to determine whether pyrheliometer data are adequate for estimating this performance. The instrument system consists of a "scanning telescope", several conventional solar instruments, and a digital electronics control and recording system. The telescope makes a scan of $+-3^0$, passing through the center of the sun. The angular resolution is approximately 1.5 minutes of arc from the center of the sun out to two solar radii, and 5 minutes from there out to 3^0. The background caused by direct solar light scattering within the telescope itself has been reduced to less than 1 percent of the intensity of the circumsolar radiation. Spectral dependence of the radiation is determined using filters. A measurement program using this telescope will be carried out at various locations in the West and Southwest. Additional instruments are being constructed for deployment for the accumulation of data at potential sites for future solar power plants. (auth)

3808 (N-75-12885) OUR PRODIGAL SUN. (National Aeronautics and Space Administration, Washington, D. C. (USA)). 1974. 16p. (NASA-EP-118). NTIS $2.25.

Characteristics of the sun are reported indicating it as a source of energy. Data from several space missions are discussed, and the solar activity cycle is presented. The corona, flares, prominences, spots, and wind of the sun are also discussed. (STAR)

3809 (N-75-15577) THIRD SOLAR WIND CONFERENCE: A SUMMARY. Russell, C. T. (California Univ., Los Angeles (USA). Inst. of Geophysics and Planetary Physics). Jul 1974. 29p. (NASA-CR-141322; NASA-SP-308). NTIS.

From third solar wind conference; Pacific Grove, Calif. (25 Mar 1974).

The Third Solar Wind Conference consisted of nine sessions. The following subjects were discussed: solar abundances; the history and evolution of the solar wind; the structure and dynamics of the solar corona; macroscopic and microscopic properties of the solar wind; cosmic rays as a probe of the solar wind; the structure and dynamics of the solar wind; spatial gradients; stellar winds; and interactions with objects in the solar wind. The invited and contributed talks presented at the conference are summarized. (auth)

3810 (N-75-17277) ANALYSIS OF OGO-5 AND OSO-7 X-RAY DATA. Final Report. Moore, R. L. (California Inst. of Tech., Pasadena (USA)). Feb 1975. 8p. (NASA-CR-142131). NTIS $3.25.

The physical nature of solar flares implied by the data was studied. The empirical results were obtained primarily from the OGO-5 and OSO-7 x-ray data in combination with optical data. The principal conclusions regarding the physics of flares are the following. (1) Flares are produced by magnetic field reconnection. (2) The resulting thermal x-ray plasma is cooled primarily by heat conduction rather than by radiative cooling. (3) The heating and cooling of the thermal x-ray plasma are approximately in balance during the maximum phase of the flare. (auth)

3811 (N-75-17278) X-RAY BURSTS FROM SOLAR FLARES BEHIND THE LIMB. Roy, J. R.; Datlowe, D. W. (California Inst. of Tech., Pasadena (USA)). 1975. 54p. (NASA-CR-142132; BBSO-0143). NTIS $4.25.

X-ray bursts are identified from the UCSD OSO-7 x-ray experiment data. X-ray spectroheliograms of OSO-5, H alpha activity at the limb, and the emergence and disappearance of sunspot groups at the limb were studied and 17 active centers were found as likely seats of the X-ray bursts beyond the limb. The analysis of 37 X-ray bursts and their physical parameters is presented. Results show that (1) the distributions of maximum temperature, maximum emission measure, and characteristic cooling time of the over-the-limb events do not significantly differ from those of disk events; (2) that radiation is the dominant cooling mechanism for the hot flare plasma; and (3) that the scale height for x-ray emission in the 5-10 keV range is large. Observations show that the fraction of soft x-ray bursts which have a nonthermal component is the same on and off of the disk. Hard x-ray emission over extended regions is indicated. (auth)

3812 (N-75-17281) SLOW X-RAY BURSTS AND CHROMOSPHERIC FLARES WITH FILAMENT DISRUPTION. Roy, J. R.; Tang, F. (California Inst. of Tech., Pasadena (USA)). 1975. 31p. (NASA-CR-142151; BBSO-0141). NTIS $3.75.

The data from OGO-5 and OSO-7 x-ray experiments have been analyzed to study six chromospheric flares with filament disruption associated with slow thermal x-ray bursts. Filament activation accompanied by a slight x-ray enhancement precedes the first evidence of H alpha flare by a few minutes. Rapid increase of the soft x-ray flux is accompanied by a sudden brightening of the filament when viewed on-band H alpha. Thereafter the bright chromospheric strands reach their maximum brightness with maximum x-ray flux. Any plateau or slow decay phase in the x-ray flux is accompanied by a quieting in filament activity and even by filament re-appearance. The height of the disrupted prominence is proportional to the soft x-ray flux for the August 3, 1970 limb occulted event. (auth)

3813 (N-75-18144) SOLAR X-RAY STUDIES. Final Report. Vorpahl, J. A. (Aerospace Corp., Los Angeles, Calif. (USA)). 5 Jan 1975. 3p (NASA-CR-142164). NTIS $3.25.

The hard X-ray component in the impulsive phase of solar flares is reported. Observations from OGO-5 OSO-7 show no center-to-limb effect of soft X-ray flare. These soft events were plotted separately as a function of solar longitude. (STAR)

3814 (N-75-19114) OGO-V RADIO BURST ANALYSIS. Haddock, F. T. (Michigan Univ., Ann Arbor (USA)). Feb 1975. 3p. (NASA-CR-142232; UM/RAO-75-1). NTIS $3.25.

An analysis is presented of data on the km-wave type-3 bursts associated with H alpha flares. A list of published papers based on previous analysis is also presented. (STAR)

3815 (N-75-21200) TIME-DEPENDENT 2.2 MeV AND 0.5 MeV LINES FROM SOLAR FLARES. Wang, H. T.; Ramaty, R. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Mar 1975. 40 p. (NASA-TM-X-70865; X-660-75-74). NTIS $3.75.

The time dependences of the 2.2 MeV and 0.51 MeV gamma ray lines from solar flares are calculated and the results are compared with observations of the 1972, August 4 and 7 flares. Time lag between the nuclear reactions and the formation of these two lines are caused, respectively, by capture of the neutrons, and by deceleration of the positrons and decay of the radioactive nuclei. Results show that the calculation is consistent with the observed rise of the 2.2 MeV line on August 4, and it does not require different time dependences for the accelerated protons and electrons in the flare region. The above lags can explain the delayed gamma ray emission observed on August 7. Positrons of energies greater than about 10 MeV could be detected in interplanetary space following large solar flares. (auth)

3816 (N-75-21205) ORIGIN AND IMPLICATIONS OF GAMMA RAYS FROM SOLAR FLARES. Ramaty, R. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Apr 1975. 11p. (NASA-TM-X-70862; X-660-75-79). NTIS $3.25.

Solar flares studied in the gamma ray region provide essential information on accelerated nuclei that can be obtained in no other way. A multitude of physical processes, such as particle acceleration, nuclear reactions, positron and neutron physics and kinematical line broadening, come into consideration at gamma ray energies. Gamma ray observations are complementary to hard X ray observations, since both provide information on accelerated particles. It appears that only in the gamma ray region do these particles produce distinct spectral lines. (auth)

3817 (N-75-23450) UNUSUAL EMISSION OF IRON NUCLEI FROM THE SUN. Gloeckler, G.; Hovestadt, D.; Vollmer, O.; Fan, C. Y. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). 25 Apr 1975. 14p. (NASA-CR-142712). NTIS $3.25.

Sustained emission of low energy solar particles with a composition richer in iron than oxygen is observed in the time period 1974 May 7 to 17. Between 0.7 and 4 MeV/nucleon the relative abundances of C:O:Fe are 0.24:1:1.35. It was suggested that these observations provide indication for effects of heavy ion enrichment in the lower corona of the sun. (auth)

3818 (N-75-23451) SOLPRO: A COMPUTER CODE TO CALCULATE PROBABILISTIC ENERGETIC SOLAR PROTON FLUENCES. Stassinopoulos, E. G. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Apr 1975. 27p. (NASA-TM-X-72573; NSSDC-75-11). NTIS $3.75.

A code was developed for the calculation of interplanetary solar proton fluences at 1 AU for the active years 1977 to 1983. The fluences are presented as functions of mission duration tau, energy threshold E, and confidence level Q. For a given combination of tau and Q, the routine determines whether ordinary or anomalously large events are to be considered, and in the latter case, the number of anomalously large events that are predicted by probabilistic theory for the specified mission duration. The code is described in detail. A listing and sample calculations are included. (auth)

3819 EVIDENCE OF LOCAL ION HEATING IN SOLAR WIND HIGH SPEED STREAMS. Bame, S.J.; Asbridge, J.R.; Feldman, W.C.; Peter Gary, S.; Montgomery, M.D. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). Geophys. Res. Lett. 2: No. 9, 373-375 (Sept 1975).

The thermal anisotropies near the peaks of proton distributions are observed to vary characteristically across two simple high speed streams. Before the time of maximum velocity gradient $T_{\|}$ of the core distribution is greater than $T_{\perp}$ but afterwards, and persisting throughout the remainder of the high speed region, $T_{\|} < T_{\perp}$. This implies that it may not be necessary to invoke extended ion heating close to the sun to explain enhanced ion temperatures associated with high speed streams and that the T-V relation may be primarily the result of local heating near 1 AU. (auth)

3820 ON THE ORIGIN OF THE UPPER CUTOFF IN THE SOLAR PROTON SPECTRUM. Pérez-Peraza, J. (Instituto de Astronomia, Universidad Nacional Autónoma de México, México City, México). J. Geophys. Res. 80: No. 25, 3535-3542 (1 Sept 1975).

The problem of the origin of the upper cutoff in the spectrum of multi-GeV solar protons is examined. This analysis concerns the case in which the upper cutoff is determined at the source level by a stochastic mechanism of acceleration. The operation of the random process at the solar source is justified in terms of a small length scale of the fluctuations of the magnetic field. The deviation of the particle spectrum from a perfect power law is explained by a discontinuity in the behavior of the mean free path of particles for acceleration. The assumption that this random acceleration step depends highly on the medium density (10^{13} cm^{-3}) and magnetic field strength (500 G) leads us to estimate a maximum rigidity greater than the measured value. We also found that the upper cutoff is imposed not by the linear dimension of the source but by this characteristic length scale of turbulence therein and that the source dimension is somewhat smaller than is usually thought. From the magnitude of some physical parameters of the source estimated in this paper the scale of turbulence of the magnetic field of about 1 km seems to be an interesting result within the framework of stochastic acceleration theory. (auth)

3821 ELECTROMAGNETIC PROCESSES IN CIRCUMTERRESTRIAL AND INTERPLANETARY SPACE OCCURRING IN AUGUST 1972 DURING SOLAR FLARES. Bondarenko, V. I.; Yukhimuk, A. K. (Inst. of Geophysics, Kiev). Geofiz. Sb.; No. 65, 55-61(1975). (In Ukrainian).

The paper deals with a complex description of the processes occuring in circumterrestrial and interplanetary space in August 1972 after high-power solar flares. The following problems are considered: Forbush-decays, magnetic and ionospheric storms, interaction of the solar plasma with the magnetosphere, heating of particles in the interplanetary space. The data of the ground stations Apatity, Tiksi, Moskva, Kiev, Alma-Ata, Tbilisi, spacecrafts Pioneer-5, Pioneer-7, Pioneer-10 are used in the paper. (auth)

3822 EXPERIMENTAL TEST OF GENERAL RELATIVITY USING TIME-DELAY DATA FROM *MARINER* 6 AND *MARINER* 7. Anderson, J.D.; Esposito, P.B.; Martin, W.; Thornton, C.L. (Jet Propulsion Laboratory, California Institute of Technology); Muhleman, D.O. Astrophys. J. 200: No. 1, 221-233 (15 Aug 1975).

Range and Doppler data from *Mariner* 6 and *Mariner* 7 have been analyzed for purposes of measuring the effect of the Sun's gravity field on S-band radio transmissions to the spacecraft. The prediction of general relativity, that the round-trip time delays between the station and the spacecraft will be increased by about 200 μs near superior conjunction, has been verified with an uncertainty of 3 percent or less.

The value for the parameter $\gamma = (1+\gamma)/2$, which multiplies the Einstein prediction of the "excess" delay in the ranging signal, is $\gamma^* = 1.00 \pm 0.03$, where the uncertainty represents a realistic standard deviation. The dominant error source on the experiment is the stochastic nongravitational forces which act on the spacecraft and which limit the accuracy of the determination of the *Mariner* orbits. Effects of free coronal electrons on the round-trip propagation also make the measurement difficult, but the coronal contribution to the error in γ^* is only about 1 percent. Separate analyses of data from *Mariner* 6 and *Mariner* 7 yield two values near unity for γ^* which differ by about 0.3 percent from each other. This and other considerations suggest that the error in the experiment is perhaps less than 3 percent. (auth)

3823 UNUSUAL EMISSION OF IRON NUCLEI FROM THE SUN. Gloeckler, G. (Department of Physics and Astronomy, University of Maryland); Hovestadt, D.; Vollmer, O.; Fan, C.Y. Astrophys. J. Lett. 200: No. 1, L45-L48 (15 Aug 1975).

Sustained emission of low-energy solar particles with a composition richer in iron than oxygen is observed in the time period 1974 May 7 to 17. Between 0.7 and 4 MeV per nucleon the relative abundances of C:O:Fe are 0.65:1:1.35. We suggest that these observations provide indication for effects of heavy-ion enrichment in the lower corona of the Sun. (auth)

3824 ON SOLAR CORONAL TEMPERATURE. Narain, U.; Chandra, S. (Atomic and Molecular Physics Research Group, Physics Department, Meerut College, Meerut-250001, India). Astrophys. J. 200: No. 1, 234-235 (15 Aug 1975).

A new calculation based on Shklovskii's method for the determination of the solar coronal temperature from line ratios is reported. The results are in reasonably good agreement with the recent theoretical calculations. (auth)

3825 RELATIVE INTENSITIES OF SOLAR EMISSION LINES OF IONS IN THE SODIUM ISOELECTRONIC SEQUENCE. Flower, D. R.; Nussbaumer, H. (Eidgenoessische Technische Hochschule, Zurich). Astron. Astrophys.; 42: No. 2, 265-268(Aug 1975).

Electron collision cross-sections and radiative transition probabilities are presented for Si^{+3}, S^{+5}, Ca^{+9}, and Fe^{+15} of the sodium isoelectronic sequence. An attempt is made to interpret the observed relative intensities of Si IV and S VI lines in terms of the electron temperatures of the emitting regions. We find that observations with improved spectral resolution will be necessary in order that the line ratios become a useful tool for temperature determinations. (auth)

3826 MACROTURBULENCE BROADENING OF SOLAR LINES WITH IMPLICATIONS FOR STELLAR STUDIES. Evans, J. C. (Kansas State Univ., Manhattan); Ramsey, L. W.; Testerman, L. Astron. Astrophys.; 42: No. 2, 237-241(Aug 1975).

This paper reports the results of numerical studies of macroturbulence broadening on solar LTE intensity profiles with the view toward applying the results toward other solar type stars. A comparison of the results for five different velocity models with spacially and temporally averaged center-to-limb observations obtained at KPNO is presented. The comparisons are made through the curve of line-width correlation and through the curve of line-shape diagram. For mildly saturated lines (about 120 mÅ), the solar macro-velocities are the most important of the velocity scale sizes in determining the shape of the line core. The unsaturated weak lines and the curve of line-width correlation do not discriminate between the two scale sizes of broadening as suggested by other studies. High accuracy photoelectric data for Procyon used on the curve of line-shape indicates that macroturbulence broadening dominates and the microturbulence component is about 1 km/s. (auth)

3827 LOOP MODEL OF ACTIVE CORONAL REGIONS. Landini, M.; Monsignori Fossi, B. C. (Astrophysical Observatory of Arcetri, Florence). Astron. Astrophys.; 42: No. 2, 213-220(Aug 1975).

The energy balance which is established in a vertical cylinder of constant pressure between the radiated energy, the energy supplied from below and dissipated over one typical scale height $1/k$, and the energy flux conducted along the temperature gradient is investigated: a model of temperature versus height is obtained. The emission measure ($\int n_e^2 dh$) versus temperature distribution is evaluated and compared with observation. A coronal active region is simulated by assembling a large number of such tubes shaped along the lines of force of a dipole field assuming that the flux of the supplied energy is proportional to the magnetic field intensity. Comparison is made with experimental data on several X-ray emission lines. (auth)

Galaxies

Refer also to abstracts 3728, 3741, 3746, 3751, 3780, 3787, 3796, and 3801.

3828 (N-75-19119) MOLECULAR HYDROGEN IN THE GALAXY AND GALACTIC GAMMA RAYS. Stecker, F. W.; Solomon, P. M.; Scoville, N. Z.; Ryter, C. E. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Feb 1975. 29p. (NASA-TM-X-70839; X-602-75-24). NTIS $3.75.

Recent surveys of 2.6 mm CO emission and 100 MeV gamma-radiation in the galactic plane reveal a striking correlation suggesting that both emissions may be primarily proportional to the line-of-sight column density of H2 in the inner galaxy. Both the gamma ray and CO data suggest a prominent ring or arm consisting of cool clouds of H2 at a galactocentric distance of approximately 5 kpc with a mean density of approximately 4 atoms/cu cm. The importance of H2 in understanding galactic gamma ray observations is also reflected in the correlation of galactic latitude distribution of gamma rays and dense dust clouds. A detailed calculation of the gamma ray flux distribution in the 0 deg to 180 deg range using the CO data to obtain the average distribution of molecular clouds in the galaxy shows that most of the enhancement in the inner galaxy is due to pion-decay radiation and the 5 kpc ring plays a major role. Detailed agreement with the gamma ray data is obtained with the additional inclusion of contributions from bremsstrahlung and Compton radiation of secondary electrons and Compton radiation from the intense radiation field near the galactic center. (auth)

3829 (N-75-22221) FAR INFRARED SPECTROSCOPY OF THE ORION NEBULA. Ward, D. B. (Cornell Univ., Ithaca, N. Y. (USA). Center for Radiophysics and Space Research). 1975. 11p. (NASA-CR-142697). NTIS $3.25.

A coarse resolution spectrum of the Orion Nebula between 65 and 125 microns is presented which closely fits the color dependence of a 75 K blackbody. A high resolution search for O III at 88.16 microns yields an upper limit below theoretical predictions. Observations were carried out in November, 1974, using the 31 cm gyrostabilized telescope mounted in the NASA Lear jet. The instrument employed was a fully liquid helium cooled grating spectrometer with a 3 mm entrance slit that gave a square beam on the sky, 5 arc minutes in diameter. The results are presented. (auth)

3830 ON THE EXISTENCE OF THE LOCAL SUPERGALAXY (LSG) AND THE DISTRIBUTION OF GALAXIES AND QSS's WITHIN THIS OBJECT. Karoji, Hiroshi (Paris-6 Univ., 75 (France). Inst. Henri Poincare). C. R. Hebd. Seances Acad. Sci., Ser. A, B; 280: No. 13, 421-423(7 Apr 1975). (In French)

The histogram of the number of galaxies as a function of the distance to the center of LSG is established. (FR)

3831 HIGH-RESOLUTION MAPS OF THE GALACTIC CENTER AT 2.2 AND 10 MICRONS. Becklin, E.E.; Neugebauer, G. (Hale Observatories, California Institute of Technology, Carnegie Institution of Washington). Astrophys. J. Lett. 200: No. 2, L71-L74 (1 Sept 1975).

Photometric maps of the central 1′ of the galactic center are presented at 2.2 and 10 μ with a spatial resolution of $\sim 2\farcs5$. Most of the 2.2-μ radiation within the central 2 pc comes from discrete sources with absolute 2.2-μ magnitudes brighter than -8. At 10 μ, nine discrete sources plus an extended ridge of emission are seen. Five of the discrete sources are located within the extended ridge and have linear dimensions and 10-μ luminosities similar to the planetary nebula NGC 7027. (auth)

3832 MEASUREMENTS OF GALACTIC NUCLEI AT 34 MICRONS. Rieke, G.H.; Low, F.J. (Steward Observatory and Lunar and Planetary Laboratory, University of Arizona). Astrophys. J. Lett. 200: No. 2, L67-L69 (1 Sept 1975).

NGC 1275, NGC 4151, Markarian 231, MGC 5195, and NGC 5253 have been observed at 34 μ. The measurements provide improved estimates for the total luminosities of these sources, and show that Markarian 231 emits nearly $10^{13}\ L_\odot$. (auth)

3833 THE RELATIVE POSTIONS OF THE OH AND H_2O MASERS IN W49N AND W3(OH). Mader, G.L. (E. O. Hulburt Center for Space Research, Naval Research Laboratory, Washington, D.C.); Johnston, K.J.; Moran, J.M.; Knowles, S.H.; Mango, S.A.; Schwartz, P.R.; Waltman, W.B. Astrophys. J. Lett. 200: No. 2, L111-L114 (1 Sept 1975).

The relative positions of the OH and H_2O masers in W49N and W3(OH) have been found by simultaneously observing both masering transitions with a very-long-baseline interferometer. In both sources the OH and H_2O features are clearly separated and occupy two distinct regions of space, separated by 48,000 AU and 18,000 AU in W49N and W3(OH), respectively. The two masering regions appear unlikely to have the same source of excitation. (auth)

3834 ASYMMETRIC HCN LINE PROFILES FROM THE ORION NEBULA. Clark, F.O. (University of Kentucky, Lexington). Astrophys. J. Lett. 200: No. 2, L115-L117 (1 Sept 1975).

The hyperfine components of the HCN $J=1$–0 transition in Orion are observed to be asymmetric. This asymmetry apparently indicates some inhomogeneity of the molecular cloud and is interpreted as due to radial motions in the source. The magnitude of these implied motions is discussed and the sense examined. Alternate interpretations are also discussed. (auth)

3835 THE COMPOSITE NATURE OF THE N GALAXY 3C 371. Miller, J.S. (Lick Observatory, Board of Studies in Astronomy and Astrophysics, University of California, Santa Cruz). Astrophys. J. Lett. 200: No. 2, L55-L59 (1 Sept 1975).

Observations of the N galaxy 3C 371 with the Lick Observatory image-tube scanner show that the spectrum has three components: the stellar absorption lines of an E galaxy, a power-law continuum of index —1.35, and a weak emission-line spectrum qualitatively similar to those observed in some giant E and radio galaxies. The derived contribution of the galaxy component is in excellent agreement with that obtained earlier by Sandage from different considerations. Comparison with the spectrum of NGC 1052 indicates that the galaxy associated with 3C 371 may be metal-poor. Measurements of the polarization show that it is high and variable on a time scale of a day. It is concluded that 3C 371 is an intermediate object, with features observed in giant E galaxies, highly variable QSOs, and BL Lacertae objects. (auth)

3836 LINEAR POLARIZATION OF THE GALACTIC RADIO EMISSION AT 102 MHz NEAR $l = 140°$, $b = +8°$. Paseka, A. M.; Popova, L. V.; Razin, V. A.; Arkhangel'skii, V. G.; Smokhvalov, Yu. E. Izv. Vyssh. Uchebn. Zaved., Radiofiz.; 18: No. 7, 926-929(1975). (In Russian)

The results of measuring a linear polarization of the galactic radio emission at 102 MHz from the part of the sky with the mean declination +64° and right ascension $1-5^h$ are presented. Observations are carried out by 12-m radio telescope. The half-power beamwidth was 15°15′ × 16°00′. The transmission band of the receiver was 1.2 MHz. Measurements were carried out by scanning separate parts of the sky. The maximum temperature of linearly-polarized radio emission at 102 MHz was measured at $\alpha = 3^h$ amounts to 6.7 ± 0.8°K (the polarization angle in the equatorial coordinate system is 160 ± 25°, in the galactic one 131 ± 25°). The obtained data together with the results of polarization measurements at the higher frequencies [1–3] testify to the fact that: (1) the degree of polarization of radiation is approximately proportional to $\lambda^{-4/3}$; (2) ionized gas concentration in the polarization region $\sim 3.10^{-3}$cm^{-3}; (3) linearly polarized radiation generates in a local galactic arm including the region in the vicinity of the solar system rather than in the objects of the nearest supernova remnants. (auth)

3837 DETECTION OF FORMIC ACID IN SAGITTARIUS B2 BY ITS 2_{11}–2_{12} TRANSITION. Winnewisser, G.; Churchwell, E. (Max-Planck-Institut für Radioastronomie). Astrophys. J. Lett. 200: No. 1, L33-L36 (15 Aug 1975).

Interstellar formic acid, HCOOH, has been detected at 4.9 GHz by its 2_{11}–2_{12} transition from the direction of the galactic center radio source Sgr B2. The emission line, which has a peak antenna temperature of 0.04 K and a full width to half-power of 24 km s^{-1}, probably results from an inversion of the $K_a=1$ doublets. The total column density of HCOOH remains uncertain. (auth)

3838 THE 2–4 MICRON SPECTRUM OF NGC 7027. Merrill, K.M.; Soifer, B.T.; Russell, R.W. (Department of Physics, University of California, San Diego). Astrophys. J. Lett. 200: No. 1, L37-L39 (15 Aug 1975).

Spectrophotometric observations of NGC 7027 from 2.1 to 4.1 μ with a resolution $\Delta\lambda/\lambda \sim 0.015$ are reported. The spectrum is rich in features, including three hydrogen recombination lines and several unidentified features. The 2-μ continuum level and the hydrogen recombination-line fluxes agree well with predictions based on the observed radio and Hβ fluxes. (auth)

3839 OXYGEN ABUNDANCES IN PLANETARY NEBULAE. Daub, C.T. (San Diego State University). Astrophys. J. 200: No. 1, 82-87 (15 Aug 1975).

The abundance of oxygen in planetaries is examined for three different physical descriptions of the density and temperature structure. A comparison of these abundances with expectations derived from an energy-balance perspective leads to the conclusion that, for the models considered here, the most satisfactory oxygen abundance is derived by assuming a uniform density and temperature for a planetary. (auth)

3840 FAR-INFRARED SPECTROSCOPY OF THE ORION NEBULA. Ward, D.B. (Center for Radiophysics and Space Research, Cornell University). Astrophys. J. Lett. 200: No. 1, L41-L43 (15 Aug 1975).

A coarse-resolution spectrum of the Orion Nebula between 75 and 120 μ closely fits the color dependence of a 75 K blackbody. A high-resolution search for O III at 88.16 μ yields an upper limit below theoretical predictions. (auth)

3841 HYPERFINE AND Λ-DOUBLING SPLITTING IN EXCITED ROTATIONAL LEVELS OF CH. Levy, D.H.; Hinze, J. (Department of Chemistry and the James Franck Institute, University of Chicago). Astrophys. J. 200: No. 1, 236-238 (15 Aug 1975).

The Λ-doubling and hyperfine splittings in the $^2\Pi_{1/2}$, $J = 1/2$, 3/2, and 5/2, and $^2\Pi_{3/2}$, $J = 3/2$ and 5/2 levels of the CH radical have been calculated using a combination of calculated molecular parameters and observed spectral frequencies. The accuracy of the calculated splittings is discussed. (auth)

3842 THE SPECTRUM AND STRUCTURE OF "MINKOWSKI'S FOOTPRINT": M 1–92. Herbig, G.H. (Lick Observatory, Board of Studies in Astronomy and Astrophysics, University of California, Santa Cruz). Astrophys. J. 200: No. 1, 1-5 (15 Aug 1975).

M 1–92 is a small elliptical nebulosity of quite high surface brightness, discovered originally by Minkowski. It is divided unequally by a dark gap so as to have the appearance of a human footprint; the overall dimensions are about 4.5 × 11.5. On infrared photographs a faint red star appears in the gap between the two lobes. Both lobes show a broad-lined P Cygni spectrum with dark components displaced shortward to −530 km s^{-1}, plus a sharp-line, low-excitation emission spectrum of H, Fe —, [Fe —], Ti —, Si —, etc., which gives a velocity of −15 km s^{-1} in the bright lobe and +17 km s^{-1} in the faint. Emission lines of [O —], [S —], [N —] are also present. The spectroscopic and photometric data can be explained if the emission spectrum observed in the nebulae actually originates near the central star, and is only scattered off dust being driven radially outward through the two lobes at a velocity of approximately 30 km s^{-1}. The central star is believed to be surrounded by a dense, flattened, circumstellar dust disk and by a much larger and more tenuous cloud. Two independent estimates suggest an axial extinction in the bright lobe of A_v=3–4 mag; the total line-of-sight extinction of the star must be considerably larger. The two lobes are thus only the polar regions of the larger cloud, illuminated by the star through the relatively transparent poles of the flattened disk. A large infrared excess is also present; it presumably originates in the dense circumstellar disk very near the star. No changes have been observed in the structure of the nebula or in the total brightness. The evolutionary state of M 1–92 is unknown. (auth)

3843 OBSERVATIONS OF QUASI-THERMAL AND MASER PHENOMENA IN ROTATIONALLY EXCITED OH. I. Rickard, L.J. (University of Chicago); Zuckerman, B.; Palmer, P. Astrophys. J. 200: No. 1, 6-21 (15 Aug 1975).

Absorption features arising from Λ-doublet transitions in a very short-lived rotationally excited state of OH have been discovered in the direction of the W3 continuum peak. Analyses of these features and of broad emission features in Sgr indicate the presence of massive regions with very high densities. An extensive search for new sources of maser emission from excited-state OH has resulted in the detection of maser features in NGC 7538, OH 69.5–1.0, M17, W51, and Orion (OH). Observations with circular polarization suggest Zeeman effects in some spectra, with inferred magnetic field strengths of several milligauss. A rapid time variation has been observed in the maser spectrum of Sgr B2, and evidence is presented for variations in W51 and W3 (continuum). (auth)

3844 DIFFERENTIAL INTERSTELLAR POLARIZATION IN THE REGION OF 6284 Å FOR HD 183143. Fahlman, G.G.; Walker, G.A.H. (Institute of Astronomy and Space Science, University of British Columbia, Vancouver, Canada). Astrophys. J. 200: No. 1, 22-29 (15 Aug 1975).

Differential polarization measurements in the region of the diffuse feature at 6284 Å in the spectrum of HD 183143 are described. The observations were made using a television detector and a Polaroid filter. No systematic change through the diffuse feature was observed, and an upper limit of ±0.4 percent is placed on the variation of polarization in the spectral region. (auth)

3845 5-GHz SURVEY OF BRIGHT GALAXIES. Sramek, R. (National Radio Astronomy Observatory, Charlottesville, Virginia). Astron. J. 80: No. 10, 771-777 (Oct 1975).

The 1135 galaxies in the *Reference Catalogue of Bright Galaxies* with declinations between +10° and +70° were surveyed at 6-cm wavelength with a 3-σ detection limit of about 30 mf.u.; of these 149 were detected. For 90 of these galaxies, spectral indices were obtained. There is a suggestion that the elliptical galaxies have flat spectra more often than the spiral galaxies. (auth)

3846 DETERMINATION OF THE DISTRIBUTION FUNCTION OF AN ELLIPTICAL GALAXY. Hunter, C. (Department of Mathematics, The Florida State University, Tallahassee, Florida). Astron. J. 80: No. 10, 783-793 (Oct 1975).

A new method is presented for constructing a collisionless distribution function for an elliptical galaxy whose mass distribution is known. The method, which involves the use of Stieltjes transforms, is used in the study of a new set of mass distributions that have two dimensionless parameters. (auth)

3847 ABSORPTIVE PROPERTIES OF SILICATE CORE-MANTLE GRAINS. Aannestad, P.A. (Steward Observatory, University of Arizona). Astrophys. J. 200: No. 1, 30-41 (15 Aug 1975).

Absorption and extinction efficiencies for silicate and silicate core-ice mantle grains are presented for olivine-type particles in the wavelength range 0.07 μ-10^3 μ, for fused quartz-type particles in the range 0.056 μ-10^3 μ, and for lunar silicate-type particles in the range 1 μ-10^3 μ. Comparison with the observed near-infrared absorption spectrum in the BN object shows that no single type of these particles can adequately accoun: for the observed 9.8 μ feature, and that a mixture of various types of silicates may be required. Fits to the relative strengths of the observed ice and silicate features give mantle-to-core volume ratios from 0.3 to 1.3. The emission efficiency at wavelengths $\gtrsim \mu$ is found to be sensitive to the presence of an ice mantle with the silicate grains following approximately a λ^{-2} law, while the core-mantle grains follow a λ^{-3} law. Upper limits to the enhancement of the far-infrared emissivity due to impurities are deduced, and it is found that only core-mantle grains can reasonably account for the observed far-infrared luminosities of many H II regions, Extinction curves for silicate and silicate core-mantle grains are compared with observation, and it is found that other types of particles than silicate core-mantle particles must account for the ultraviolet extinction as well as for much of the visible extinction. Equilibrium grain temperatures are calculated for regions of no shielding, and are found to range from about 10 K to about 20 K for grain radii 0.1 μ to 0.25 μ. (auth)

3848 A NEW UPPER LIMIT TO THE MASS LOSS FROM THE CENTRAL REGION OF THE GALAXY. Poveda, A.; Allen, C. (Instituto de Astronomia, Universidad Nacional Autónoma de México). Astrophys. J. 200: No. 1, 42-47 (15 Aug 1975).

A mass loss of 200 $M_\odot$ yr^{-1}, as has been conservatively suggested if Weber is detecting gravitational waves from an isotropic source at the galactic center, is shown to be incompatible with (*a*) the existence of old wide binaries, (*b*) the existence of globular clusters if this loss rate has been constant over the lifetime of the Galaxy, and (*c*) the observed *K*-term, even if this loss has occurred only during the last 10^8 years. From the orbit of ω Centauri in the galactic field, its observed mass distribution, and its tidal radius, it is found that an upper limit to the mass loss from a region of $\sim$1.3 kpc radius around the galactic center is 1 $M_\odot$ yr^{-1}, averaged over the lifetime of the Galaxy. The alternatives left open by this limit are briefly discussed. (auth)

3849 PHOTOGRAPHIC PHOTOMETRY OF BRIGHT GALAXIES. IV. NGC 2683. Barbon, R.; Capaccioli, M. (Astrophysical Observatory, Asiago, Italy). Astron. Astrophys.; 42: No. 2, 221-228(Aug 1975).

Surface photographic photometry in the B system of the spiral galaxy NGC 2683 is presented. Standard photometric parameters are derived following the line of this series of papers. Assuming a reasonable shape for the outermost isophotes, it is shown that the equivalent luminosity profile does follow an exponential law, thus confirming that the luminosity gradients in the outer regions of spirals are different from those in ellipticals. The direction of rotation of the spiral arms is discussed, and they are found to be trailing. Moreover, spectra taken along the major axis of the galaxy suggest the presence of deviations from circular motions. From rough estimates of the mass and the mass-to-light ratio, the distance of the galaxy is discussed. (auth)

3850 ENERGY FLUCTUATIONS OF INTERSTELLAR DUST GRAINS. Gail, H. P.; Sedlmayr, E. (Univ., Heidelberg). Astron. Astrophys.; 43: No. 1, 17-27(Sep 1975).

The fluctuations of internal temperatures of interstellar dust grains caused by the absorption of photons from the interstellar radiation field and collisions with the hot component of the interstellar gas are treated by means of a probability distribution function. A method is presented to compute this probability for a given heating mechanism and a given model for the dust grains. The resulting integral equation is discussed for the idealized case of particles emitting and absorbing radiation-like gray bodies. Numerical results are given for a monochromatic and a black-body radiation field. (auth)

3851 RADIATION FROM INHOMOGENEOUS DUSTY STROEMGREN SPHERES. Baschek, B.; Wehrse, R. (Univ., Heidelberg). Astron. Astrophys.; 43: No. 1, 29-36(Sep 1975).

The characteristic behavior of the center-to-limb variation and the integrated spectrum of dusty Stroemgren spheres is discussed on the basis of simplified models with constant gas-to-dust ratios. It is assumed that the ionization of the gas and the heating of the dust is due to a central star (of type O 6 V). The density distribution is assumed to be gaussian. The spectral region considered, ranges from radio frequencies to the near infrared (to about 0.8μ), including the region in which internal dust absorption becomes important. (auth)

3852 PHOTOGRAPHIC UBV OBSERVATIONS AND THE GALACTIC STRUCTURE IN CENTAURUS (l = 307°, b = 0°). McGruder, C. H. III. (Landessternwarte, Heidelberg-Koenigstuhl, Ger.). Astron. Astrophys.; 43: No. 1, 51-60(Sep 1975).

An area of 5□° centered at l = 307°, b = 0° has been studied by means of photographic UBV-photometry. 38.094 stars were measured by the GALAXY machine. Color excesses, frequencies and space densities of O, B, A, F main sequence stars and G, K giants are derived. A maximum in the space densities is found at r $\approx$ 0.7 kpc; other maxima are detected at r $\approx$ 1.8 kpc and r $\approx$ 3.5 kpc, coinciding with the distances of spiral arm –I and a possible spiral arm –II. The presence of spiral arm –I at l = 307° means that this arm probably extends from Carina through Sagittarius. (auth)

3853 ISOTOPES OF CARBON, NITROGEN, AND OXYGEN AS PROBES OF NUCLEOSYNTHESIS, STELLAR MASS LOSSES, AND GALACTIC EVOLUTION. Audouze, J. (Observatoire de Meudon, France); Lequeux, J.; Vigroux, L. Astron. Astrophys.; 43: No. 1, 71-83(Sep 1975).

Recent observations of CO and other interstellar molecules have conclusively shown that differences in the isotopic ratios of C N and O exist between the interstellar medium and the solar system. In particular, the interstellar medium is very probably enriched in ^{13}C by a factor $\sim$2 with respect to ^{12}C, in comparison with the solar system. These observations are examined together with those of gradients of C, O and especially N abundances with galactocentric distance in spiral galaxies. Since the processes occurring during the formation of the solar system seem unable to significantly fractionate the $^{13}C/^{12}C$ ratio, it is assumed that the interstellar gas was enriched in ^{13}C during the last 4.6×10^9 years. It is emphasized that ^{13}C, ^{14}N, and possibly also ^{17}O are mainly formed in the external regions of stars losing mass in the red giant, Mira, planetary nebula or supernova phase, while ^{15}N is produced in nova outbursts. Simple evolutionary models allow us to reconcile the time variation of the $^{12}C/^{13}C$ ratio with the strong spatial nitrogen gradient and with the absence of a spatial gradient for $^{12}C/^{13}C$. Some implications regarding the mass loss by stars and the chemical evolution of the Galaxy are discussed. Furthermore, since comets seem to have a $^{12}C/^{13}C$ ratio similar to that of the solar system they probably do not originate outside of the solar system. (auth)

3854 FORBIDDEN LINES FROM INHOMOGENEOUS NEBULAE: THE CASE OF A DENSITY DISTRIBUTION N PROPORTIONAL TO r^{-2}. Panagia, N. (Laboratorio de Astrofisica Spaziale, Frascati, Italy); Preite-Martinez, A. Astron. Astrophys.; 43: No. 1, 93-100(Sep 1975).

The formation of forbidden lines in a nebula with density distribution $N \propto r^{-2}$ is considered. It is shown that the forbidden-line-intensity-ratios (FLIR) may mimic those of constant density nebulae, whose physical conditions differ considerably from the actual ones. The limits of a FLIR analysis in terms of a constant density model are discussed. A self-consistent analysis is necessary for a correct interpretation of FLIR data, otherwise quite misleading results may be obtained: i.e. overestimate of the minimum density and the electron temperature, underestimate of the maximum density and the abundances relative to hydrogen, ad hoc ionization structure. Some considerations about the abundance determination from emission line measurements and the case of a more general density distribution are also presented. (auth)

3855 FORBIDDEN LINES IN A NEWLY FORMED H II REGION. Manfroid, J. (Univ., Liege). Astron. Astrophys.; 43: No. 1, 149-152(Sep 1975).

The forbidden lines emitted by C^+, N^+, N^{2+}, O^+, O^{2+}, Ne^+, and Ne^{2+} in a newly formed H II region have been calculated during its initial evolution. (auth)

3856 CHARACTERISTICS OF PLANETARY NEBULAE AND H II REGIONS BASED ON λ = 1.35 cm CONTINUUM MEASUREMENTS. Alcina Braz, M.; Jardim, J. O.; Kaufmann, P. (Mackenzie Univ., Sao Paulo, Brazil). Astron. Astrophys.; 43: No. 1, 153-155(Sep 1975).

Physical parameters are derived and discussed for stronger H II regions and planetary nebulae for which continuum radio data at λ = 1.35 cm was obtained. The study includes southern hemisphere planetary nebulae IC-418, NGC-6302, NGC-6369, and H II regions RCW-65, RCW-87, RCW-99, H 2–3 and H 2–6. (auth)

3857 HIGH RESOLUTION RADIO AND OPTICAL OBSERVATIONS OF NGC 6888. Wendker, H. J. (Max-Planck-Institut fuer Radioastronomie, Bonn); Smith, L. F.; Israel, F. P.; Habing, H. J.; Dickel, H. R. Astron. Astrophys.; 42: No. 2, 173-185 (Aug 1975).

NGC 6888 is a filamentary nebulosity associated with the Wolf-Rayet star HD 192163. Maps are presented with a resolution of 5 arcmin at 11 cm and better than 1.5 arcmin at H_α and at 6 cm,

21 cm and 49 cm (continuum). There is a smooth component to the H_α radiation which presumably originates from gas between the filaments. From comparison of the line and continuum intensities, it is found that the smooth component has essentially the same temperature as the filaments. The mechanism by which the filaments are created and maintained is not clear. (auth)

3858 INTERCLOUD HI GAS IN THE DIRECTION OF CASSIOPEIA A AND CYGNUS A. Mebold, U.; Hills, D. L. (Max-Planck-Institut fuer Radioastronomie, Bonn). Astron. Astrophys.; 42: No. 2, 187-194(Aug 1975).

The absorption of the intercloud-interarm HI-gas has been detected in the directions of Cas A and Cyg A with the 100-m telescope in Effelsberg. Spin temperatures greater than 3000°K and about 6000°K are derived, respectively, for these sources. It is shown that there exists no systematic error of the spin temperatures even though the gas is not homogeneously distributed around and in front of discrete radio sources. (auth)

3859 85α RECOMBINATION LINE SURVEY OF NGC 2024. MacLeod, J. M.; Doherty, L. H.; Higgs, L. A. (Herzberg Inst. of Astrophysics, Ottawa). Astron. Astrophys.; 42: No. 2, 195-204(Aug 1975).

The 85α recombination lines of hydrogen, helium, and carbon have been observed at a grid of 29 positions, centered on the continuum peak of the H II region NGC 2024 (Orion B, W 12). Contour maps of radial velocity, LTE electron temperature, and the distributions of ionized hydrogen, helium, and carbon are presented. The radial velocity of the ionized hydrogen varies systematically from +2 km/s to +8 km/s across the nebula. This variation is interpreted as due to streaming motions of ionized gas away from neutral clouds to the south and back sides of the nebula. The ionized helium zone is smaller than the ionized hydrogen zone, and centered ~1′ northwest of the continuum peak. An ionized carbon zone, extended in size, shows little velocity variation. Its position and size agree well with those of a 93μ map of the region. A narrow hydrogen recombination line and a heavy element line have been detected. The latter may be predominantly due to silicon. A model of NGC 2024 has been constructed, consisting of two exciting stars, (one B 0 and the other a B 0.5 supergiant) and a layer of differentially absorbing dust lying across the southern half of the nebula. This model accounts satisfactorily for the observed radio parameters. (auth)

3860 NEUTRAL HYDROGEN CONTENT OF ELLIPTICAL GALAXIES. Huchtmeier, W. K. (Hamburger Sternwarte, Hamburg); Tammann, G. A.; Wendker, H. J. Astron. Astrophys.; 42: No. 2, 205-211(Aug 1975).

Nine elliptical galaxies have been searched for 21 cm line emission of neutral hydrogen with the 100 m radio telescope in Effelsberg. Using measurements of 6 elliptical galaxies we derive for the mean hydrogen mass of an elliptical $M_{HI} < 3 \times 10^7\ M_\odot$. The upper limits imply $M_{HI}/M_T < 5 \times 10^{-4}$ and $M_{HI}/L < 0.01$. For two elliptical galaxies, NGC 4278 and 4636, we suspect a "marginal line" which would correspond to a value of $10^8\ M_\odot$ of neutral hydrogen in these galaxies. Implications for the evolution of elliptical galaxies are discussed. (auth)

3861 DENSITY DISTRIBUTION IN CLUSTERS OF GALAXIES. Taff, L. G. (Univ. of Pittsburgh). Astron. Astrophys.; 42: No. 2, 243-246(Aug 1975).

The number counts for thirteen clusters of galaxies (thirty-five separate counts) have been examined. For these rich, symmetric clusters there always appears to be spherically symmetric departures from monotonicity. In particular, special note of these features has been made for the Perseus, A 2199, and A 31 clusters. Furthermore, similar features appear in the X-ray data for the Coma and Perseus clusters. The optical data has been analyzed by three methods. The first and second approaches have not yielded significant quantitative evidence to support the reality of these features. Lastly, the majority of the data (23 counts of 11 clusters) were combined after scaling by the cluster radius to reduce the effect of counting errors. Here there may be evidence to document the existence of secondary maxima in the projected surface densities. If real such maxima would be a cosmological distance indicator. The publication of morphologically separate number counts might help to further clarify the situation. (auth)

3862 VALUE OF $R = A_V/E_{B-V}$. Schalen, C. (Univ. of Lund, Sweden). Astron. Astrophys.; 42: No. 2, 251-258(Aug 1975).

The various methods used by H. L. Johnson to determine R and his results are briefly discussed. Also an attempt is made to derive R from determinations of total extinctions and total color excesses in dark clouds. A value R = 3.1 is suggested. Variations of R seem to be small. (auth)

Cosmology

3863 (AAS-75-041) RELATIVITY MISSION WITH TWO COUNTER-ORBITING POLAR SATELLITES. Van Patten, R. A.; Everitt, C. W. F. (Stanford Univ., Calif. (USA)). 1975. 34p. (CONF-750739-3). American Astronautical Society, Tarzana, CA.

From 66th annual conference of international district heating association; Skytop, Pennsylvania, USA (23 Jun 1975).

In 1918, J. Lense and H. Thirring calculated that a moon in orbit around a massive rotating planet would experience a nodal dragging effect due to general relativity. An experiment to measure this effect with two counter-orbiting drag-free satellites in polar earth orbit is described. For a 2½ year experiment, the measurement accuracy should approach 1 percent. In addition to precision tracking data from existing ground stations, satellite-to-satellite Doppler ranging data are taken at points of passing near the poles. New geophysical information on both earth harmonics and tidal effects is inherent in the polar ranging data. (auth)

3864 (AAS-75-42) COLLISION AVOIDANCE FOR TWO COUNTER-ORBITING POLAR SATELLITES. Schaechter, D. B.; Breakwell, J. V.; Van Patten, R. A.; Everitt, C. W. F. (Stanford Univ., Calif. (USA)). 1975. 17p. (CONF-750739-2). American Astronautical Society, Tarzana, CA.

From 66th annual conference of international district heating association; Skytop, Pennsylvania, USA (23 Jun 1975).

Two counter orbiting polar satellites will be required for the "Relativity Mission" devised by Van Patten and Everitt. Inasmuch as the two satellites will pass close to one another twice per orbit for 2½ years, some precautionary measure must be taken to insure that a collision is avoided especially since the orbit is not very accurately predictable from ground tracking. Possible schemes involve introducing a moderate orbital plane separation, or a slight orbital eccentricity. A more desirable scheme involves small orbital plane changes by lateral impulses every three months at an equatorial crossing, so as to avoid disturbing the orbital nodes. (auth)

3865 (AAS-75-102) RELATIVITY EXPERIMENT ON HELIOS: A STATUS REPORT. Anderson, J. D.; Melbourne, W. G.; Cain, D. L.; Lau, E. K.; Wong, S. K.; Kundt, W. (Jet Propulsion Lab., Pasadena, Calif. (USA)). 1975. 37p. (CONF-750739-4). American Astronautical Society, Tarzana, CA.

From 66th annual conference of international district heating association; Skytop, Pennsylvania, USA (23 Jun 1975).

The S-band range and Doppler data and the orbit of the spacecraft in the gravitational field of the sun are used to measure the effects of general relativity in the solar system and to measure the quadrupole moment in the gravity field of the sun. (BJG)

3866 THE REDSHIFT-APPARENT MAGNITUDE RELATION WHEN AN INTRINSIC (i.e. SOURCE EFFECT) COMPONENT OF THE OBSERVED REDSHIFTS IS ASSUMED. Le Denmat, G. (Paris-6 Univ., 75 (France). Inst. Henri Poincare). C. R. Hebd. Seances Acad. Sci., Ser. A, B; 280: No. 1, 17-19(6 Jan 1975). (In French)

From a phenomenological point of view, the assumption that redshifts could not be entirely due to the Doppler-Einstein effect, but partly proceed from an effect intrinsic to the sources is considered. In this way, to write an Hubble-like relation between the observed redshifts Z and the apparent magnitudes of the sources, one needs to distinguish, in the observed Z, the cosmological component Z_c (Doppler-Einstein effect) and the intrinsic component Z_i (source effect). (FR)

3867 PAIR CREATION IN EXPANDING UNIVERSES. Raine, D.J.; Winlove, C.P. (Department of Astrophysics, South Parks Road, Oxford, England). Phys. Rev. D 12: No. 4, 946-951 (15 Aug 1975).

A new theory of particle production in background gravitational fields is presented as an alternative to Hamiltonian diagonalization. We calculate a vacuum-vacuum transition amplitude and identify the expected pair creation rate in terms of the amount by which the modulus of this amplitude differs from unity. The method is applied to some Robertson-Walker cosmological models and is shown to give results differing from those obtained by Hamiltonian diagonalization. (auth)

3868 EINSTEIN-CARTAN COSMOLOGIES WITH A MAGNETIC FIELD. Raychaudhuri, A.K. (Physics Department, Presidency College, Calcutta 12, India). Phys. Rev. D 12: No. 4, 952-955 (15 Aug 1975).

This note points out that the natural generalization of the Maxwell equations in spaces having torsion leads to a breakdown of the gauge invariance and charge conservation principle. The equations are, however, taken in a form so as to preserve gauge invariance; and the possibility of bounce is investigated in the presence of a magnetic field for Bianchi type-I universes with $p = 0$ and $p = \rho$. (auth)

3869 MHD GRAVITY WAVES. Perona, G. E. (Istituto de Elettronica e Telecomunicazioni, Politecnico, Turin). Radio Sci.; 10: No. 7, 705-710(Jul 1975).

The dispersion relation of gravity waves propagating in a conducting atmosphere in the presence of a magnetic field has been evaluated. Extreme simplifying assumptions have been adopted in an effort to reach simple results. In this way, the applicability of the results to any real situation is highly doubtful. However, a qualitative and intuitive understanding of the influence of conductivity and magnetic field on the dispersion relation of gravity waves is more easily reached. (auth)

3870 ALLENDE METEORITE: COSMOCHEMISTRY'S ROSETTA STONE. Mason, B. (Smithsonian Institution, Washington, DC). Acc. Chem. Res.; 8: No. 7, 217-224(Jul 1975).

The detailed chemical and mineralogical analyses of the Allende meteorite, a large carbonaceous chondrite. The arrival of the meteorite coincided with the Apollo II acquisition of lunar samples, and simultaneous comparative studies were performed on these materials. Elemental abundances, mineralogical composition, isotopic age estimates, and structure are discussed. (5 figures, 3 tables, 26 references) (GHT)

3871 SCALAR PARTICLE CREATION IN AN ANISOTROPIC UNIVERSE. Berger, B.K. (Physics Department, Yale University, New Haven, Connecticut 06520). Phys. Rev. D 12: No. 2, 368-375 (15 July 1975).

The problem of quantized scalar field creation in an anisotropic spatially homogeneous background universe is reexamined from a Schrödinger-picture point of view. For each mode a complete set of orthonormal wave functions, ψ_N, is obtained using the method of Salusti and Zirilli. These wave functions are valid at all times even if there is an initial cosmological singularity and depend only on the solution of the classical equation of motion. The wave functions are fixed completely by requiring the classical solution to have positive-frequency WKB form when the universe reaches the stage of adiabatic expansion. These wave functions are eigenfunctions of a conserved number operator which has the usual particle interpretation in the adiabatic regime. An intitial state near the singularity is chosen as a superposition of the wave functions, ψ_N, and the particle number in the adiabatic regime is calculated. For plane-wave initial states, which follow the classical behavior near the singularity, the final particle number depends only on the parameters of the initial wave packet. For an initial state which instantaneously diagonalizes the Hamiltonian, an (arbitrary) initial time must be chosen. If the mode in question is in the adiabatic regime at that time almost no particle creation occurs. If it is not adiabatic, creation occurs and becomes infinite if the initial time is taken to be that of the singularity. This creation is a consequence of the failure of particle number to be well defined in this regime. Comparisons with other particle-creation studies are made. (auth)

3872 CERTAIN SPACES THAT VIOLATE THE CAUSALITY PRINCIPLE. Voronov, N.A. (Institute of Theoretical and Experimental Physics). JETP Lett. 21: No. 10, 284-285 (20 May 1975).

Exact solutions, particular cases of which are the solutions of Gödel and Van Stockum, were obtained for Einstein's equation with a cosmological term inside rotating matter without pressure. (auth)

3873 RADIATION FROM A HYDROGEN-LIKE ATOM. Semenov, V. P. (All-Union Scientific-Research Inst. of Optical-Physical Measurement, Moscow). Fizika (Zagreb); 18: No. 1, 131-132(1975). (In Russian)

Dozmorov and Semenov (1973) have obtained a solution of the Maxwell equations that extends the Coulomb solution in electrostatics to cover the case of a curved cosmological background. It was assumed that the space possesses a metric that can be realized by one of the Friedmann models, and that the electromagnetic field itself does not introduce noticeable distortions of the geometry. Some aspects of the problem that previously were not accounted for are discussed, limiting the analysis of the "open" cosmological model. Particular attention is given to the influence of the cosmological background (which was shown to lead to a modification of the Coulomb potential) on the energy spectrum of a hydrogen-like atom. (IAA)

Planetary Phenomena

Refer also to abstract 3870.

3874 (N-75-14675) HETEROGENEITIES IN THE SOLAR NEBULA. Clayton, R.; Grossman, L.; Mayeda, T. K.; Onuma, N. (Chicago Univ., Ill. (USA)). 1974. 14p. (NASA-CR-141243). NTIS $3.25.

From Soviet-American conference on the cosmochemistry of the moon and planets; Moscow, USSR (4 Jun 1974).

Oxygen isotopic compositions of the high-temperature phases in carbonaceous chondrites define a mixing line with an O-16 rich component and show little superimposed chemical isotope fractionation. Within a single inclusion in Allende, variations of delta O-18 and delta O-17 of 39 percent are found. The ordinary chondrites are slightly displaced from the terrestrial fractionation trend, implying that at least 0.2 percent of the oxygen in terrestrial rocks was derived from the O-16 rich component. (STAR)

3875 (N-75-14687) CLUES IN THE RARE GAS ISOTOPES TO EARLY SOLAR SYSTEM HISTORY. Reynolds, J. H. (California Univ., Berkeley (USA). Dept. of Physics). 1974. 29p. (NASA-CR-141247). NTIS $3.75.

From Soviet-American conference on the cosmochemistry of the moon and planets; Moscow, USSR (4 Jun 1974).

Rare gases in meteorites and lunar samples are discussed stimulating the discovery of the solar wind. Radioactive isotopes are examined, making a correlation to the origin of the solar system. It is shown that the heights of the peaks above the horizontal lines represent the spectrum of the fissiogenic sample. Nuclear tracks of iodine, xenon, and plutonium detected in lunar rocks are also explained. (STAR)

3876 (N-75-15514) RESEARCH IN SPACE PHYSICS AT THE UNIVERSITY OF IOWA. VanAllen, J. A. (Iowa Univ., Iowa City (USA). Dept. of Physics and Astronomy). Dec 1974. 35p. (NASA-CR-141278). NTIS $3.75.

Various research projects in space physics are summarized. Emphasis is placed on: the study of energetic particles in outer space and their relationships to electric, magnetic, and electromagnetic fields associated with the earth, the sun, the moon, the planets, and interplanetary medium; observational work on satellites of the earth and the moon, and planetary and interplanetary spacecraft; phenomenological analysis and interpretation; observational work by ground based radioastronomical and optical techniques; and theoretical problems in plasma physics. Specific fields of current investigations are summarized. (auth)

3877 (N-75-15574) DIFFUSION MODELS FOR JUPITER'S RADIATION BELT. Jacques, S. A.; Davis, L. Jr. (California Inst. of Tech., Pasadena (USA). Dept. of Physics). 10 Nov 1972. 34p. (NASA-CR-141967). NTIS $3.75.

For Jet Propulsion Lab.

Solutions are given for the diffusion of trapped particles in a planetary magnetic field in which the first and second adiabatic invariants are preserved but the third is not, using as boundary conditions a fixed density at the outer boundary (the magnetopause) and a zero density at an inner boundary (the planetary surface). Losses to an orbiting natural satellite are included and an approximate evaluation is made of the effects of the synchrotron radiation on the energy of relativistic electrons. Choosing parameters appropriate to Jupiter, the electrons required to produce the observed synchrotron radiation are explained. If a speculative mechanism in which the diffusion is driven by ionospheric wind is the true explanation of the electrons producing the synchrotron emission it can be concluded that Jupiter's inner magnetosphere is occupied by an energetic proton flux that would be a serious hazard to spacecraft. (auth)

3878 (N-75-17020) ANALYSIS OF PROTON AND ELECTRON SPECTROMETER DATA FROM OGO-5 SPACECRAFT. Final Report, 1 July 1973-31 July 1974. Pomerantz, M. A. (Bartol Research Foundation, Swarthmore, Pa. (USA)). 13 Feb 1975. 95p. (NASA-CR-142078). NTIS $4.75.

The interaction between the geomagnetic and interplanetary magnetic fields is studied through its effects upon the intensities of solar electrons reaching the polar caps during times of strongly anisotropic electron fluxes in the magnetosheath. During the particle event of November 18, 1968, electrons of solar origin were observed outside the magnetopause with detectors aboard OGO-5. Correlative studies of these satellite observations and concurrent measurements by riometers and ionospheric forward scatter systems in both polar regions revealed that the initial stage of the associated polar cap absorption event is attributable to the arrival of solar electrons. Evidence of a north-south asymmetry in the solar electron flux, at a time when the interplanetary magnetic field vector was nearly parallel with the ecliptic plane, supports an open magnetospheric model. The analysis indicates that an anisotropic electron flux may be isotropized at the magnetopause before propagating into the polar regions. (auth)

3879 (N-75-17022) EARTH AS A RADIO SOURCE: THE NONTHERMAL CONTINUUM. Progress Report. Gurnett, D. A. (Iowa Univ., Iowa City (USA). Dept. of Physics and Astronomy). Dec 1974. Contract N00014-68-A-0196-0009. 54p. NTIS $3.25.

A weak nonthermal continuum, radiated by the earth from energetic electrons in the outer radiation zone, is studied. It is shown that the frequency spectrum of the continuum radiation consists of two components, a trapped component, which is per-

manently trapped within the magnetosphere at frequencies below the solar wind plasma frequency, and an escaping component which propagates freely away from the earth at frequencies above the solar wind plasma frequency. Direction finding measurements and measurements of the spatial distribution of intensity for both components indicated that the continuum radiation is generated (1) in a broad region which extends through the morning and early afternoon immediately beyond the plasmapause boundary, and (2) over a broad range of latitudes, including the magnetic equator. Possible mechanisms by which this radiation is generated, including gyro-synchrotron radiation from energetic electrons in the outer radiation zone, are discussed. (auth)

3880 (N-75-17185) THERMODYNAMICS AND PHASE SEPARATION OF DENSE FULLY-IONIZED HYDROGEN–HELIUM FLUID MIXTURES. Stevenson, D. J. (Cornell Univ., Ithaca, N. Y. (USA). Lab. of Atomic and Solid State Physics). Jan 1975. 34p. (NASA-CR-142109). NTIS $3.75.

The free energy of a hydrogen-helium fluid mixture is evaluated for the temperatures and densities appropriate to the deep interior of a giant planet such as Jupiter. The electrons are assumed to be fully pressure-ionized and degenerate. In this regime, an appropriate first approximation to the ionic distribution functions can be found by assuming hard sphere interactions. Corrections to this approximation are incorporated by means of the perturbation theory of Anderson and Chandler. Approximations for the three-body interactions and the nonlinear response of the electron gas to the ions are included. It is predicted that a hydrogen-helium mixture, containing 10 percent by number of helium ions, separates into hydrogen-rich and helium-rich phases below about 8000^{0}K, at the pressures relevant to Jupiter (4 to 40 Megabars). It is also predicted that the alloy occupies less volume per ion than the separated phases. The equations of state and other thermodynamic derivatives are tabulated. Implications of these results are discussed. (auth)

3881 (N-75-19097) OBSERVATIONS OF PLASMAS IN THE JOVIAN MAGNETOSPHERE. Frank, L. A.; Ackerson, E. L.; Wolfe, J. H.; Mihalov, J. D. (Iowa Univ., Iowa City (USA). Dept. of Physics and Astronomy). Jan 1975. Contract N00014-68-A-0196-0009. 43p. (NASA-CR-142231). NTIS $3.75.

Large intensities of low-energy protons were observed deep within the Jovian magnetosphere with the plasma instrumentation on Pioneer 10 during the encounter of this space probe with Jupiter. The energy range of the electrostatic analyzer was 108 eV to 4.80 keV during encounter. Inside the flux tubes of the Galilean moon Io is a "plasmasphere" of protons with relatively high densities, 100/cu cm, extending toward the planet to at least 2.8 R sub J. The characteristic thermal energies of these protons are about 100 eV. The flux tubes of Io are positioned on a severe decrease of these densities with increasing Jovicentric radial distances-a plasmapause. The relationship of Io to this plasmapause is quite likely to be fundamental to the Io-modulation of decametric radio emissions. The proton densities in the vicinity of Io are also sufficiently high to limit the azimuthal extent of the partial torus of hydrogen gas from Io by the mechanism of charge exchange. At greater distances, beyond the plasmapause, is found a great torus of plasma encircling Jupiter with densities in the range 10 to 15 per cu cm and thermal energies about 400 eV. The moon Europa is embedded in this torus, or "ring current." This ring current is extended into a thin plasma disc at greater radial distances. (auth)

3882 (N-75-21189) INTERPLANETARY MAGNETIC FIELD DATA BOOK. King, J. H. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Apr 1975. 382p. NTIS $10.25.

An interplanetary magnetic field (IMF) data set is presented that is uniform with respect to inclusion of cislunar IMF data only, and which has as complete time coverage as presently possible over a full solar cycle. Macroscale phenomena in the interplanetary medium (sector structure, heliolatitude variations, solar cycle variations, etc.) and other phenomena (e.g., ground level cosmic-ray events) for which knowledge of the IMF with hourly resolution is necessary are discussed. Listings and plots of cislunar hourly averaged IMP parameters over the period November 27, 1963, to May 17, 1974, are presented along with discussion of the mutual consistency of the IMF data used herein. The magnetic tape from which the plots and listings were generated, which is available from the National Space Science Data Center (NSSDC), is also discussed. (auth)

3883 (N-75-22236) JOVIAN ELECTRON SPECTRUM AND SYNCHROTRON RADIATION AT 375 cm. Birmingham, T. J. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Apr 1975. 15p. (NASA-TM-X-70876; X-602-75-94). NTIS $3.25.

The synchrotron radiation expected at Earth from the region L equals 2.9-5 R /sub J/ of Jupiter's magnetosphere is calculated using the Pioneer 10 electron model. The result is approximately 21 flux units (f.u.). This value is to be compared with 6.0 + 0.7 f.u., the flux density of synchrotron radiation measured from Jupiter's entire magnetosphere in ground-based radio observations. Most of the radiation at 375 cm is emitted by electrons in the 1 to 10 MeV range. If the electron model used for calculations is cut off below 10 MeV, the calculated flux is reduced to approximately 4 f.u., a level compatible with the radio observations. (auth)

3884 (N-75-22237) BULK LUNAR ELECTRICAL CONDUCTIVITY. Leavy, D. L. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Earth and Planetary Sciences). Jan 1975. 200p. (NASA-CR-142696). NTIS $7.00.

Thesis.

The electrical conductivity structure was studied of a spherically layered moon consistent with the very low frequency magnetic data collected on the lunar surface and by Explorer 35. In order to obtain good agreement with the lunar surface magnetometer observations, the inclusion of a void cavity behind the moon requires a conductivity at shallow depths higher than that of models having the solar wind impinging on all sides. By varying only the source parameters, a conductivity model can be found that yields a good fit to both the tangential response upstream and the radial response downstream. This model also satisfies the dark side tangential response in the frequency range above 0.006 Hz, but the few data points presently available below this range do not seem to agree with the theory. (auth)

3885 (N-75-23440) MEASUREMENT OF THE LUNAR NEUTRON DENSITY PROFILE. Woolum, D. S.; Burnett, D. S.; Furst, M.; Weiss, J. R. (California Inst. of Tech., Pasadena (USA)). 1974. Contract NAS9-12585. 45p. (NASA-CR-141782). NTIS $3.75.

An in situ measurement of the lunar neutron density from 20 to 400 g/sq cm depth between the lunar surface was made by the Apollo 17 Lunar Neutron Probe Experiment using particle tracks produced by the B 10(n, alpha)Li7 reaction. Both the absolute magnitude and depth profile of the neutron density are in good agreement with past theoretical calculations. The effect of cadmium absorption on the neutron density and in the relative Sm 149 to Gd 157 capture rates obtained experimentally implies that the true lunar Gd157 capture rate is about one half of that calculated theoretically. (auth)

3886 JUPITER'S MOLECULAR HYDROGEN LAYER AND THE MAGNETIC FIELD. Smoluchowski, R. (Princeton University, and Cavendish Laboratory, Cambridge, England). Astrophys. J. Lett. 200: No. 2, L119-L121 (1 Sept 1975).

High pressures and temperatures in the molecular hydrogen layer of Jupiter can lead to electrical conductivity which is high enough to affect the hydromagnetic dynamo mechanism and to help explain the strength of the higher than dipolar components of the magnetic field observed by *Pioneer* 10 and 11. (auth)

3887 INTERPLANETARY SPACE AND MAGNETOSPHERE. Oya, H. (Tohoku Univ., Sendai (Japan). Faculty of Science). Denki Gakkai Zasshi; 94: No. 11, 965-969(Nov 1974). (In Japanese).

The interaction between plasma wind and the magnetic field of a planet is explained. The existence of the solar wind, that is the plasma flow from the sun, was demonstrated with artificial satellites. The observed data showed that the velocity of the solar wind fluctuated in the range of 275 to 850 km/s, the density 1 to 10/cc and the wind included the magnetic field of 3 to 7 γ. This magnetic field makes the Archimedes spiral, and the solar wind plasma usually flows along the spiral. Various disturbances are superimposed on the solar wind plasma, and cause many electromagnetic phenomena in case of the interaction with planets. Among them, the shock waves associated with the solar flare are the most interesting phenomena, and were investigated with a satellite. The solar wind interacts with geomagnetic field. The structure of the geomagnetic field was studied with the satellite IMP-1. The long tail of magnetic field and the existence of magnetic neutral surface were discovered. The interaction between the solar wind and Jupiter has been studied, and the phenomena indecameter wave region was used for the study. The observation by the satellite Pioneer gave useful data. The radiation belt of Jupiter was investigated especially in cm-wave band. The mechanism of decameter wave generation has been explained by many people, but the explanations were not successful. Recently, the conversion of electron cyclotron waves to electromagnetic waves was proposed. This theory explains the spectra of the decameter waves successfully, and the decameter waves can be used for the study on the structures of magnetosphere and magnetic field of jupiter. (TSS)

3888 MOON AND PLANETS. Shimizu, M. (Tokyo Univ. (Japan). Inst. of Space and Aeronautical Science). Denki Gakkai Zasshi; 94: No. 11, 969-973(Nov 1974). (In Japanese).

Results of the observation of moon and planets with artificial satellites are described. Photographs of the moon were taken, and rocks and sands on the surface of the moon were carried back to the earth by artificial satellites. The analysis of these materials gave the composition, temperature and history of the moon. Internal structure, moment of inertia, and data concerning gravity were estimated by moon-quake. Photographs of mercury were taken, and the surface of mercury was studied. The atmosphere of Venus was observed with satellites, and it was found that it consists almost of CO_2. The pressure and the temperature on the surface of Venus were also measured, and were 90 atm and 470°C, respectively. Flow of the atmosphere was observed from the photographs. Analysis of ultra-violet spectra gives the density of components of atmosphere and temperature. Orographic figure of mars was made by the observation of infra-red or ultra-violet spectra. The height of the highest mountain is 27 km, and the depth of the great valley of 4,000 km long is 6 km. Vertical temperature distribution and the components of atmosphere were found. Most information concerning Jupiter was obtained by the observation from ground, except some information with the satellite Pioneer. The vertical temperature distribution of atmosphere and the local structure of clouds were observed by the Pioneer. Existence of He element was also recognized. Studies of the moon and planets are important for the research of the atmosphere of earth and the history of life. (TSS)

3889 JUPITER'S ATMOSPHERE: PROBLEMS AND POTENTIAL OF RADIO OCCULTATION. Eshleman, R. (Stanford Univ., CA). Science; 189: No. 4206, 876-878(12 Sep 1975).

The atmospheric temperature-pressure profiles derived from the Pioneer 10-Pioneer 11 radio occultation experiment are mutually consistent but differ markedly from the results of other investigations. Current studies indicate that the occultation interpretation contains errors that were made very large by an inherent magnification effect, and that these errors have both geometrical and equipment sources. The apparent consistency between the Pioneer 10 and the Pioneer 11 results must be considered fortuitous. Despite these difficulties, the occultation technique, when optimally instrumented and carefully interpreted, retains its potential for atmospheric profile measurements of high accuracy and resolution. (auth)

3890 TRAPPED HELIUM AND ARGON AND THE FORMATION OF THE ATMOSPHERE BY DEGASSING. Fisher, D. E. (Univ. of Miami, FL). Nature (London); 256: No. 5513, 113-114(10 Jul 1975).

Some radiogenic ^4He and ^{40}Ar data are reported from measurements in the glass margins of deep sea basalts, and comments are offered on their applicability to discussions on the formation of the Earth's atmosphere by degassing from the solid Earth. Discussions of such degassing generally assume either catastrophic or continuous mechanisms, but it is thought that these two sets of models need not be regarded as mutually exclusive. The history of the Earth may include a catastrophic event, followed by continuous degassing. (UK)

3891 MOLECULAR PRODUCTION RATES IN COMET KOHOUTEK. A'Hearn, M.F.; Cowan, J.J. (Astronomy Program, University of Maryland, College Park, Maryland 20742). Astron. J. 80: No. 10, 852-860 (Oct 1975).

Narrow-band photometry was carried out on Comet Kohoutek over a moderately wide range of heliocentric distances (0.66–1.77 AU). Production rates for C_2 and CN seem to vary as $r^{-3.5\pm0.5}$. C_3 abundance is comparable to that for CN and C_2. The comet was very dusty at large, preperihelion distances and, for comparable heliocentric distances, was less dusty after perihelion than before. There was a major outburst of both dust and molecules on 1 and 2 December. (auth)

3892 FURTHER STUDIES OF LINE EMISSION FROM IO. Brown, R.A.; Goody, R.M.; Murcray, F.J. (Center for Earth and Planetary Physics, Harvard University); Chaffee, F.H. Jr. Astrophys. J. Lett. 200: No. 1, L49-L53 (15 Aug 1975).

A one-dimensional profile of the sodium emission near Io is presented. The maximum apparent emission rate is about 30 kR for the D_2 line, and the profile falls to half-height at about 4' from Io. A high-resolution spectrum is analyzed for the thermal line width of the sodium atoms in the near-Io cloud. The FWHM is 68 ± 13 mÅ, which implies a sodium kinetic temperature of 5200 ± 2300 K. An upper limit of 5 kR is set to the apparent emission rate of neutral calcium at 4227 Å. (auth)

PHYSICS (ATMOSPHERIC)

Auroral and Ionospheric Phenomena

Refer also to abstracts 3709, 3821, and 3920.

3893 STEADY STATE FINITE AMPLITUDE RAYLEIGH-TAYLOR MODES IN SPREAD F. Chaturvedi, P.K.; Kaw, P.K. (Physical Research Laboratory, Ahmedabad, India). Geophys. Res. Lett. 2: No. 9, 381-383 (Sept 1975).

We present some special steady state solutions of the nonlinear one-dimensional set of equations describing the Rayleigh-Taylor instability. This instability is believed to be one of the possible mechanisms responsible for equatorial spread F and we discuss the relevance of our results to some recent experimental observations. (auth)

3894 MATHEMATICAL REPRESENTATION OF THE AURORAL OVAL. Holzworth, R.H. (Physics Department and Space Sciences Laboratory, University of California, Berkeley, Ca. 94720); Meng, C. Geophys. Res. Lett. 2: No. 9, 377-380 (Sept 1975).

A curve fitting procedure for mathematically representing the auroral oval is described. It is shown that the Feldstein ovals and quiet auroral ovals of the night side in DMSP photographs can be approximated by an offset circle, plus a small ($\lesssim 1°$ magnitude) Fourier component in corrected geomagnetic coordinates. Parameters are introduced, Θ and (θ_0, φ_0), that indicate the dynamic motion of the auroral oval size and center location, respectively. Using the parameter Θ, an analysis of several DMSP photographs shows a strong correlation between the southward interplanetary magnetic field ($-B_z$) and the size of the auroral oval. (auth)

3895 NEUTRAL ATMOSPHERIC COMPOSITION, PLASMA DENSITY, AND ELECTRON TEMPERATURE AT *F* REGION HEIGHTS. Prölss, G.W.; von Zahn, U. (Universität Bonn, Bonn, Federal Republic of Germany); Raitt, W.J. J. Geophys. Res. 80: No. 25, 3715-3718 (1 Sept 1975).

This study investigates the connection between neutral composition, plasma density, and electron temperature at *F* region heights and mid-latitudes by using in situ measurements obtained by instruments aboard the Esro 4 satellite. It is shown that considerable day-to-day variations in the neutral composition are closely followed by similar changes in the ionospheric plasma density; this is especially obvious during disturbed conditions. Furthermore, the expected inverse relationship between the electron temperature and plasma density is clearly shown in the data. The following sequence of events is suggested to occur during a negative ionospheric storm: A decrease in the O/N_2 ratio causes a decrease in ionization, which in turn produces an increase in the electron temperature. (auth)

3896 FURTHER EVIDENCE FOR THE FARLEY-BUNEMAN INSTABILITY IN THE POLAR CAP IONOSPHERE. Iversen, I.B.; D'Angelo, N. (Danish Space Research Institute, Lyngby, Denmark); Olesen, J.K. J. Geophys. Res. 80: No. 25, 3713-3714 (1 Sept 1975).

Ionospheric dc electric fields are correlated with ionosphere backscatter results, providing further evidence for the occurrence of the Farley-Buneman instability in the polar cap. (auth)

3897 MEASUREMENTS OF 3914-Å LIGHT PRODUCTION AND ELECTRON SCATTERING FROM ELECTRON BEAMS ARTIFICALLY INJECTED INTO THE IONOSPHERE. Israelson, G.; Winckler, J.R. (School of Physics and Astonomy, University of Minnesota, Minneapolis, Minnesota 55455). J. Geophys. Res. 80: No. 25, 3709-3712 (1 Sept 1975).

Measurements of electron backscatter and photon fluxes at 3914 Å excited by a 40-keV artificial electron beam were made on an ionospheric sounding rocket, Echo 3 launched from Fairbanks, Alaska, on April 17, 1974. The backscattered electron fluxes were found to have a constant value independent of altitude, indicating no dependence on the atmospheric density and being several orders of magnitude higher than that predicted by Coulomb scattering. This result confirms measurements on the Echo 1 and 2 experiments. The origin of this anomalous scattering has not been identified. In contrast, photon emission from the ambient atmosphere excited by the beam at 3914 Å varied directly with the change in the density of N_2 molecules. A rocket 'halo' of high-intensity backscattering and photon emission accompanied beam injections close to 90° local magnetic pitch angle and was probably caused by beam scattering from the rocket. (auth)

3898 AURORAL ELECTRIC FIELD HEATING: ITS IMPLICATIONS IN THE ALTITUDE PROFILE OF IONIC COMPOSITION AND EMISSIONS. Prasad, S.S.; Furman, D.R. (Department of Physics and Astronomy, University of Florida, Gainesville, Florida 32611). J. Geophys. Res. 80: No. 25, 3701-3704 (1 Sept 1975).

We have studied the case of a bright auroral arc (peak ionization rate, $\simeq 10^5$ cm^{-3} s^{-1}) accompanied by an intense electric field ($\simeq 50$ mV m^{-1}), taking into account, in a simpleminded approximate way, the vertical upwelling of the neutrals produced by the heating. Our results show that the altitude profiles of the ion concentration and of the number densities of minor neutral constituents like N, NO, and $O_2(^1\Delta_g)$ depart significantly from their respective values when the vertical upwelling is neglected. It appears that dynamic and nonlocal effects associated with the heating should be taken into account in assessing the problems and paradoxes that arise in connection with the interpretation of the anomalously large O^+ and NO densities and the intense 1.27-μ emission based upon equilibrium and local chemistry. (auth)

3899 THE FARLEY INSTABILITY AND THE POLAR CAP *E* FIELD. Primdahl, F. (Division of Geophysics, Danish Meteorological Institute, Copenhagen, Denmark); Olesen, J.K.; Spangslev, F. J. Geophys. Res. 80: No. 25, 3698-3700 (1 Sept 1975).

The theoretical distributions over the polar cap of the growth rates of the gradient and the Farley-Buneman two-stream instabilities are compared to the measured distribution of the 'slant *E* condition' (SEC) on polar cap ionograms. The Farley instability seems to be the most likely source of the SEC, and this opens the possiblity of detecting by means of ground-based ionospheric Doppler radars whether the polar cap *E* field is above or below a critical field and, if above, of determining the direction of the *E* field and the magnitude of the critical field. (auth)

3900 ATMOSPHERIC VERTICAL GAMMA RAY FLUX IN THE MeV RANGE. Schönfelder, V.; Lichti, G. (Max-Planck-Institut für Physik und Astrophysik, Institut für extraterrestrische Physik, Garching, West Germany). J. Geophys. Res. 80: No. 25, 3681-3684 (1 Sept 1975).

On February 27, 1973, gamma ray measurements in the energy range 1.5–10 MeV were performed with a balloon-borne double Compton telescope from Palestine, Texas. The telescope had a mean acceptance cone of 20° half angle. From this measurement the spectra of vertical atmospheric gamma rays could be derived for various depths. These spectra are presented here and compared with other theoretical and experimental work. (auth)

3901 SPATIAL AND TEMPORAL DISTRIBUTIONS OF MAGNETIC EFFECTS OF AURORAL ELECTROJETS AS DERIVED FROM *AE* INDICES. Allen, J.H.; Kroehl, H.W. (Environmental Data Service, National Oceanic and Atmsopheric Administration, Boulder, Colorado 80302). J. Geophys. Res. 80: No. 25, 3667-3677 (1 Sept 1975).

In deriving auroral electrojet 2.5-min. magnetic activity indices for 1970, simple statistics were kept that tabulated the time and frequency of contribution of index values by each of the 11 geomagnetic observatories whose records were used in the derivation. Systematic patterns were noted in the times of most frequent observation of extreme *H* deviations by each station for both quiet and disturbed hours. On the average, AL was most often derived from records of stations located about 3 1/4 hours past local geomagnetic midnight, LGM (peak westward electrojet effect); a second prominent time of occurrence of extreme negative *H* values came at 11 1/4 hours after LGM; AU was most often derived from stations located 6 1/2 hours before LGM (peak eastward electrojet effect); and a second prominent time of occurrence of extreme positive *H* values came at about 6 1/4 hours after LGM. The secondary peak times of index contribution are shown to be consistent with quiet time current sources apparently equatorward of the auroral zone. The UT daily pattern of average hourly values of AU is shown to vary seasonally, being lowest in winter, intermediate during equinoctial months, and highest during summer. No clear diurnal UT dependence can be seen in disturbed hour averages of AU. The average hourly AL values for disturbed hours are not clearly differentiated by season but appear to have a broad span of higher values from 1200 to 2100 UT. A composite map is included of regions within which auroral electrojet currents would produce the systematic extreme *H* deviations revealed in the derivation of 1970 AE(11). Preliminary analyses of AE indices for 1966 through 1971 give results that agree with these conclusions. (auth)

3902 EFFECT OF PARALLEL ELECTRIC FIELDS ON THE WHISTLER MODE WAVE PROPAGATION IN THE MAGNETOSPHERE. Gupta, G.P.; Singh, R.N. (Applied Physics Section, Institute of Technology, Banaras Hindu University, Varanasi, India). J. Geophys. Res. 80: No. 25, 3649-3654 (1 Sept 1975).

The effect of parallel electric fields on whistler mode wave propagation has been studied. To account for the parallel electric fields, the dispersion equation has been analyzed, and refractive index surfaces

for magnetospheric plasma have been constructed. The presence of parallel electric fields deforms the refractive index surfaces which diffuse the energy flow and produce defocusing of the whistler mode waves. The parallel electric field induces an instability in the whistler mode waves propagating through the magnetosphere. The growth or decay of whistler mode instability depends on the direction of parallel electric fields. It is concluded that the analyses of whistler wave records received on the ground should account for the role of parallel electric fields. (auth)

3903 A NEW LOOK AT RADAR AURORAL MOTIONS. Greenwald, R.A.; Ecklund, W.L. (Aeronomy Laboratory, Environmental Research Laboratories, NOAA, Boulder, Colorado 80302). J. Geophys. Res. 80: No. 25, 3642-3648 (1 Sept 1975).

During October 1974, three modifications were temporarily added to the NOAA radar auroral backscatter facility located at Anchorage, Alaska. These modifications included (1) a multiple azimuth antenna system. (2) an on-line computer for processing amplitude and mean Doppler profiles of the radar backscatter, and (3) a 13-band Barker coder. In combination with the radar these modifications provided data relevant to understanding both the microscopic and the macroscopic nature of the radar aurora. Appreciable structure was often found in the Doppler velocity profiles of radar auroral irregularities. Doppler velocities of nearly 2000 m/s were observed. By combining scatter amplitude profiles and mean Doppler profiles from the five azimuths we have produced contour maps of the scatter intensity and the Doppler velocity. The scatter intensity maps often indicate appreciable temporal and spatial structure in the radar auroral irregularities, corroborating the results of Tsunoda et al. (1974). The mean Doppler contour maps indicate that there is also appreciable temporal and spatial structure in the flow velocities of radar auroral irregularities. At those times when there appears to be large-scale uniformity in the irregularity flow, the Doppler velocity varies with azimuth in a manner that is consistent with a cosine-dependent azimuthal variation. (auth)

3904 RADAR OBSERVATIONS OF AURORAL ELECTROJET CURRENTS. Greenwald, R.A.; Ecklund, W.L.; Balsley, B.B. (Aeronomy Laboratory, NOAA Environmental Research Laboratories, Boulder, Colorado 80302). J. Geophys. Res. 80: No. 25, 3635-3641 (1 Sept 1975).

Radar auroral backscatter as observed with a 50-MHz radar is compared with electrojet currents deduced from a set of four Alaskan magnetometers. This comparison indicates that diffuse radar auroral irregularities are collocated with the currents to within the spatial resolution afforded by the magnetometer network. This result implies that radar auroral backscatter may be a useful new technique for monitoring the location and direction of electrojet currents. The significance of this spatial association is discussed in terms of the gradient drift and two-stream plasma instabilities. Some consideration is given to relating radar backscatter intensity and electrojet current strength. (auth)

3905 SATELLITE OBSERVATIONS OF X RAYS ASSOCIATED WITH ENERGETIC ELECTRON PRECIPITATION NEAR THE TRAPPING BOUNDARY. Imhof, W.L.; Nakano, G.H.; Reagan, J.B. (Lockheed Palo Alto Research Laboratory, Palo Alto, California 94304). J. Geophys. Res. 80: No. 25, 3629-3634 (1 Sept 1975).

A study is made of energetic electron precipitation near the trapping boundary by observing bremsstrahlung X rays with a broad angle collimated Ge(Li) X ray spectrometer on board a spinning low-altitude (~750 km) polar-orbiting satellite. With this new technique, X ray intensities are measured as a function of view direction and satellite location, and thus nearly simultaneous observations of the electron precipitation patterns over a broad area are provided. Data are presented which indicate that electron precipitation spikes may occur near the trapping boundary and remain there for time duration as long as 3 min. During some unusual cases the X ray data indicate electron precipitations at high latitudes that are very dynamic in intensity and in position with respect to the trapping boundary. Examples of such dynamic precipitation events are presented and compared with other steady cases having similar geometries. (auth)

3906 A COORDINATED TWO-SATELLITE STUDY OF ENERGETIC ELECTRON PRECIPITATION EVENTS. Imhof, W.L.; Nakano, G.H.; Gaines, E.E.; Reagan, J.B. (Lockheed Palo Alto Research Laboratory, Palo Alto, California 94304). J. Geophys. Res. 80: No. 25, 3622-3628 (1 Sept 1975).

A new technique for studying the spatial/temporal variations of energetic electron precipitation events is investigated. Data are presented in which precipitating electrons were measured simultaneously on two coordinated polar-orbiting satellites and the bremsstrahlung produced by the electrons precipitating into the atmosphere was observed from one of the satellites. Two electron spectrometers measuring the intensities and energy spectra of electrons of >130 keV were located on the oriented satellite 1971-089A (altitude, ≃800 km), whereas a single similar spectrometer measuring electrons of >160 keV was located on the spinning low-altitude (~750 km) satellite 1972-076B. The X rays of >50 keV were measured with a 50-cm³ germanium spectrometer placed on the 1972-076B satellite. With the coordinated data a study is made of events in which large fluctuations were observed in the precipitating energetic electron intensities. In the examples presented the satellite X ray data alone demonstrate that the spatially integrated electron influx was constant in time, and when the X ray data are combined with the direct electron measurements from the two satellites, the resulting data suggest that the major features in the flux profiles were primarily spatial in nature. The combination of X ray and electron measurements from two satellites is shown to provide an important method for studying and attempting to resolve spatial and temporal effects. (auth)

3907 THE EQUATORWARD BOUNDARY OF THE DIFFUSE AURORA AND AURORAL SUBSTORMS AS SEEN BY THE ISIS 2 AURORAL SCANNING PHOTOMETER. Lui, A.T.Y.; Anger, C.D. (Department of Physics, University of Calgary, Calgary, Alberta, Canada); Akasofu, S. J. Geophys. Res. 80: No. 25, 3603-3614 (1 Sept 1975).

The auroral distribution and activity over a large portion of the northern polar region are examined on the basis of 58 Isis 2 scanning auroral photometer pictures. These large-scale pictures clearly show the dynamic variation in the location of the auroral oval. The invariant latitude θ_p of the equatorward boundary of the diffuse auroral belt at local midnight is found to be a useful parameter in characterizing the size of the auroral oval and auroral activities. As θ_p increases, the probability of seeing a quiet oval increases, and the probability of seeing substorms decreases. Based on their longitudinal extent (which appears to be related to their intensities), substorms roughly fall into two types, 'confined' and 'widespread,' although such a distinction is not always clear-cut. Both types of substorms can occur along a contracted oval ($\theta_D > 66°$); however, confined substorms occur more often along a contracted oval than along a normal oval ($66° \geq \theta_D \geq 65°$) or an expanded oval ($\theta_D < 65°$). It is shown that the AE index is often inadequate to identify substorms or to determine their onset times. This is especially true for substorms along a contracted oval and for confined substorms along a normal oval. (auth)

3908 THE AURORAL ELECTROJET AND GLOBAL AURORAL FEATURES. Kamide, Y.; Akasofu, S. (Geophysical Institute, University of Alaska, Fairbanks, Alaska 99701). J. Geophys. Res. 80: No. 25, 3585-3602 (1 Sept 1975).

The distribution of equivalent current vectors of polar magnetic substorms, relative to luminous auroral features of global scale, is examined by comparing a number of DMSP satellite photographs with the simultaneous ground magnetic data. The westward auroral electrojet is the dominant feature. It flows along the diffuse aurora in the midnight and morning sectors as well as along the vicinity of active westward traveling surges in the evening sector. The present study confirms the early finding by Harang (1946) and Akasofu et al. (1965) that the westward electrojet does not end in the midnight meridian but that it extends into the evening sector along the poleward half of the auroral oval. The eastward current flows mostly equatorward of discrete auroras (perhaps along the diffuse aurora) in the evening sector, but sometimes it flows near or in the region of discrete arcs of a stretched or looped form. An accurate distribution of the westward and eastward currents across an evening meridian cannot, however, be obtained from the present study. (auth)

3909 OBSERVATION OF HeII (304 A) GLOW. Hayakawa, S.; Murakami, T.; Nagase, F.; Tanaka, Y.; Yamashita, H. (Nagoya Univ. (Japan). Dept. of Physics). Tokyo Daigaku Uchu Koku Kenkyusho Hokoku; 10: No. 3, pt.B, 603-609(Sep 1974). (In Japanese).

Observation of HeII (304 Å) was performed by using a proportional counter carried by the rocket K-9M-44. A thin polypropylene film was used for the window of the counter. Soft X-ray was cut by reflecting the incident radiation with a chromium mirror. A LiF filter was used to study the contribution of Ly α. The rocket K-9M-44 was shot on Aug. 27, 1973. The top was opened at the height of 76 km, and the rocket reached the highest altitude of 341 km 300 seconds after the shoot. Observation was made for 480 seconds. The spin period was 0.422 sec., and the half-angle of precession was about 8°. The transmissivity for the window film and the reflection by the mirror were estimated as a function of wave length. The counter selectively detects the radiation with $\lambda > 100$ Å. The contribution of various components of radiation was also estimated from the observation with the LiF filter. The directional distribution of the HeII (304 Å) glow was obtained. The distribution was analyzed as the composite of isotropic and geocorona components. The intensity of each component is about 0.3 R/sr. This experiment was a preliminary one, and proved that a thin window proportional counter can be used for the observation of XUV radiation. (JA)

3910 FREQUENCY SPECTRA OF VLF PLASMA WAVES OBSERVED BY JAPANESE IONOSPHERIC SOUNDING ROCKET K-9M-41. Matsumoto, H. (Kyoto Univ. (Japan). Ionosphere

Research Lab.); Miyatake, S.; Kimura, I. Rep. Ionosphere Space Res. Jpn.; 28: No. 3, 89-109(Sep 1974).

Controlled experiments on nonlinear wave-wave and wave-particle interactions in ionospheric plasma were performed by the Japanese sounding rocket K-9M-41. Both spontaneously- and artificially-stimulated plasma waves in the VLF range were observed. Processed spectrograms of these waves are given in this report. Before the electron beam was injected into the surrounding plasma, various plasma waves such as the ion acoustic waves excited parametrically by the transmitted, large-amplitude electron plasma wave, hiss-like emissions and LHR emissions were observed. Even triggered "risers" were found to be triggered by the LHR emission whose spectrum is very similar to that of the so-called ASE. After the electron beam with energy lower than 3 eV was injected, periodic U-shaped discrete emissions were observed. The frequency of these emissions was lower than the LHR frequency and decreased as the beam energy was increased. For the purpose of theoretical analysis, the measured plasma parameters around the rocket are given, and some kinds of observed plasma waves are analyzed as well. (auth)

3911 PROPAGATION OF AN ALFVEN WAVE THROUGH THE INTERFACE INTO THE ISOTOPIC MEDIUM. Pavlov, V. A. (Leningrad State Univ.). Izv. Vyssh. Uchebn. Zaved., Radiofiz.; 18: No. 5, 630-635(1975). (In Russian).

The propagation of an Alfven wave excited by an infinitely thin pulse ring through the interface is considered. Both media are assumed to be homogeneous. One of them is an anisotropic plasma and the other is isotropic. Expressions are received for the magnetic field of both media. The magnetic field is estimated in the case of the ionosphere. (auth)

3912 - EXCITATION AND PROPAGATION OF LARGE-SCALE ELECTROSTATIC FIELDS UNDER IONOSPHERIC CONDITIONS. Gershman, B. N.; Samsonov, A. V. (Gorky State Univ., USSR). Izv. Vyssh. Uchebn. Zaved., Radiofiz.; 18: No. 5, 663-672(1975). (In Russian).

The behaviour of large-scale electrostatic fields under ionospheric conditions is considered. Both the field excitation due to wind motion of neutral gas and penetration from E-region into ionospheric F-region are simultaneously analysed. The conditions responsible for more effective field generation are discussed. (auth)

3913 GENERATION AND TRANSFER THEORY OF LARGE-SCALE ELECTROSTATIC FIELDS IN THE NEAR-EQUATORIAL IONOSPHERIC REGION. Samsonov, A. V. (Gorky State Univ., USSR). Izv. Vyssh. Uchebn. Zaved., Radiofiz.; 18: No. 5, 682-687(1975). (In Russian).

The problem of excitation of electric fields due to the motion of the neutral gas and of transfer of these fields out of E-region into ionospheric F-region is solved under the conditions of near-equatorial ionosphere in the approximation of a stratified model. (auth)

3914 INFLUENCE OF NONSTATIONARY ELECTRIC FIELDS ON $N_e(h,t)$-PROFILES IN THE NIGHTTIME IONOSPHERIC F2-REGION. Deminov, M. G.; Kozlov, V. K. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Izv. Vyssh. Uchebn. Zaved., Radiofiz.; 18: No. 5, 688-692(1975). (In Russian).

The solution of the nonstationary continuity equation of an electron-ion gas is obtained and analysed taking into account recombination, diffusion and rapidly changing external electric fields (E). It is shown that for the definite values of dE/dt a sharp increase in concentration may be observed near maximum (h_m) in contrast to the stationary case. (auth)

3915 PARAMETRIC DECAY IN THE IONOSPHERIC PLASMA. Gusev, G. A.; Pustovalov, V. V.; Silin, V. P. (Lebedev Inst. of Physics, Moscow). Izv. Vyssh. Uchebn. Zaved., Radiofiz.; 18: No. 7, 935-947(1975). (In Russian).

A parametric decay propagating along a constant external magnetic field of a circularly polarized electromagnetic pump wave into two similar potential oscillations with the low hybrid resonant frequency in plasma with magnetized electrons is studied. The spectrum and increment of parametric instability are found. The threshold pump field, the wave numbers extremal for pumping the instability and the direction of propagation of oscillations are determined under collisional dissipation conditions. It is shown that one and same threshold field is achieved for some (two or three) different wave numbers. The dependence of extremal wave numbers on the direction of propagation is analytically and graphically analyzed. The applicability of the results obtained to the plasma of the outer ionosphere of the Earth is shown. (auth)

3916 RELIABLE IONOSONDE FOR CONTINUOUS AUTOMATIC OPERATION. Morgan, M. G.; Pratt, B. (Dartmouth Coll., Hanover, NH). Radio Sci.; 10: No. 10, 859-866(Oct 1975).

Combining time-tested techniques with modern electronic components, an inexpensive ionosonde producing high quality records and capable of unattended automatic operation for extended periods has been designed. Four instruments were built at a cost in 1967, exclusive of labor, of $2000 apiece. Three have been operated continuously for five years at a rate of one ionogram every two minutes, being attended but once a week to change the film. One of these ran 23 months with no maintenance whatsoever. (auth)

3917 SENSITIVITY OF hf CIRCUIT SIMULATIONS TO ELECTRON DENSITY MODELS. Rush, C. M.; Edwards, W. R, Jr. (Air Force Cambridge Research Labs., Hanscom Air Force Base, MA). Radio Sci.; 10: No. 10, 867-874(Oct 1975).

The dependence of HF propagation parameters on the form of the electron density model used in circuit simulation calculations is investigated. It is seen that for identical values of the F_2 region critical frequency and maximum height, no one of the selected models consistently reproduces observed electron density profiles better than any other. The differences in HF circuit parameters resulting from the use of different electron density models are seen to be significantly less than the uncertainty in the simulated parameters that arises from the inability to specify or predict the ionospheric structure with perfect accuracy. (auth)

3918 THEORETICAL STUDY OF GYRORESONANCES WITH APPLICATION TO ROCKET EXPERIMENTS. Bitoun, J.; Fleury, L.; Higel, B. (Centre National d'Etudes des Telecommunications, Issy-les-Moulineaux, France). Radio Sci.; 10: No. 10, 875-889(Oct 1975).

The waveforms and envelopes of resonance signals observed in the ionosphere at 2, 3, 4, and 5f/sub H/ by rocket experiment are compared with the analytical results provided by a spatial ray-tracing procedure which takes the gradient of Earth's magnetic field into account. An approximate calculation yields the algebraic expression of the wave damping from whence the decrease of the received signals is deduced versus time as well as their frequency variations. (auth)

3919 ALL-SKY-CAMERA FORMAT FOR RADAR AURORAL STUDIES. Fremouw, E. J.; Fang, D. J. (Stanford Research Inst., Menlo Park, CA). Radio Sci.; 10: No. 10, 891-904(Oct 1975).

Installation of a phased-array antenna on a UHF radar located at Homer, Alaska, makes possible a variety of data presentations for studying the radar aurora. In this paper a data handling procedure is described that permits rather direct comparison of radar auroral developments with optical auroral displays. The procedure involves coordinate transformation of digitized radar data to produce a display resembling an all-sky-camera photograph from a selected location beneath the radar's field of view in the E layer. Presented are five representative case studies of auroral developments as displayed in the radar all-sky-camera format and simultaneously recorded by means of optical all-sky cameras located in central Alaska (Fort Yukon and Chatanika). (auth)

Magnetospheric Phenomena

Refer also to abstract 3887.

3920 (N-75-18821) MAGNETOSPHERIC AND AURORAL PLASMAS: A SHORT SURVEY OF PROGRESS, 1971–1975. Frank, L. A. (Northwestern Univ., Evanston, Ill. (USA). Dept. of Astronomy). Contract N00014-68-A-0196-0009. 86p. (NASA-CR-142299). NTIS $4.75.

Milestones in research of auroral and magnetospheric plasmas for the past quadrennium 1971–1975 are reviewed. Findings, including those of the polar cusp, the polar wind, the explosive disruptions of the magnetotail, the interactions of hot plasmas with the plasmapause, the auroral field-aligned currents, and the striking "inverted-V" electron precipitation events, are reported. Solutions to major questions concerning the origins and acceleration of these plasmas are discussed. A comprehensive bibliography of current research is included. (auth)

3921 THE DOMINANT MODE OF STANDING ALFVÉN WAVES AT THE SYNCHRONOUS ORBIT. Cummings, W.D.; Countee, C.; Lyons, D.; Wiley, W. III (Department of Physics, Grambling State University, Grambling, Louisiana 71245). J. Geophys. Res. 80: No. 25, 3705-3708 (1 Sept 1975).

Low-frequency oscillations of the earth's magnetic field recorded by the University of California at Los Angeles magnetometer on board ATS 1 have been examined for the 6-month interval January-June 1968. Using evidence from Ogo 5 and ATS 5 as well as the data from ATS 1, we argue that the dominant mode at ATS 1 must be the

fundamental rather than the second harmonic of a standing Alfvén wave. We also conclude that these transverse oscillations are more accurately associated with magnetically disturbed days than with quiet days. Both of these results represent changes of tentative conclusions based on our initial analysis. From 14 instances when oscillations of distinctly different periods occurred during the same time interval at ATS 1 we also conclude that higher harmonics can exist. The period ratio in seven of the 14 cases corresponds to the simultaneous occurrence of the second harmonic with the fundamental, and four other cases could be identified as the simultaneous occurrence of the fourth harmonic with the fundamental. (auth)

3922 DAWN-DUSK MAGNETOSHEATH PLASMA ASYMMETRIES AT 60 R_E. Fenner[1], M.A.; Freeman, J.W. Jr. (Department of Space Physics and Astronomy, Rice University, Houston, Texas 77001). J. Geophys. Res. 80: No. 25, 3693-3697 (1 Sept 1975).

A study of data from the Apollo lunar surface suprathermal ion detector experiment (Side) package shows that plasma flow and energy parameters in the dusk magnetosheath are much better correlated with geomagnetic activity than those in the dawn magnetosheath. This result is in agreement with a dawn-dusk asymmetry in the magnetosheath magnetic field and in the bow shock configuration. The different orientations between the mean interplanetary magnetic field direction and the shock normal for the magnetosheaths suggest an explanation of the difference in the plasma parameters on the two sides. (auth)

3923 MAGNETOTAIL BOUNDARY MOTION ASSOCIATED WITH GEOMAGNETIC SUBSTORMS. Maezawa, K. (Institute of Space and Aeronautical Science, University of Tokyo, Tokyo, Japan). J. Geophys. Res. 80: No. 25, 3543-3548 (1 Sept 1975).

Motions of the magnetotail boundary during substorms are investigated by the satellite data analysis. It is found that the magnetotail radius increases during 1–2 hours before the substorm expansion phase onset. Shortly after the onset time the tail radius begins to decrease rapidly and recovers to the presubstorm value generally within about 1 hour of the expansion phase onset. Time history of the increment ΔR in the tail radius resembles that of the lobe magnetic field magnitude. This confirms that both phenomena are manifestations of the increase in the total magnetic flux in the tail lobe. The average increment ΔR in the tail radius in the region $-30R_E \geq X \geq -70R_E$ satisfies the inequality $0.5R_E \leqslant \Delta R \leqslant 4R_E$, the probable value being 1–2 R_E. This value accounts for 15–45% of the total flux increase in the tail lobe. (auth)

3924 PROTONS AS THE PRIME CONTRIBUTORS TO STORM TIME RING CURRENT. Berko, F.W. (Goddard Space Flight Center, Greenbelt, Maryland 20771); Cahill, L.J. Jr.; Fritz, T.A. J. Geophys. Res. 80: No. 25, 3549-3552 (1 Sept 1975).

Following a large sudden commencement on June 17, 1972, a large magnetic storm evolved, with a well-developed main phase and recovery phase. Explorer 45 (S^3-A), with its apogee near 16 hours local time in June, measured the equatorial particle populations and magnetic field throughout this period. By use of data obtained during the symmetric recovery phase it is shown that through a series of self-consistent calculations, the measured protons, with energies from 1 to 872 keV, can account for almost all of the observed ring current magnetic effects within the limits of experimental uncertainties. This enables us to set an upper limit to the heavy ion contribution to the storm time ring current of a few percent of the proton contribution. (auth)

3925 RELATIONSHIP BETWEEN THE INTERPLANETARY MAGNETIC FIELD AND 'ISOLATED SUBSTORMS'. Hirshberg, J.; Holzer, T.E. (High Altitude Observatory, National Center for Atmospheric Research, Boulder, Colorado 80303). J. Geophys. Res. 80: No. 25, 3553-3556 (1 Sept 1975).

The study of 54 'isolated substorms' by Foster et al. (1971) is reexamined, and five different explanations of the results of this study are found to be consistent with the data. For each of the five explanations the decay time of the *AE* index is found not to be characteristic of internal magnetospheric processes but to be due to data selection. In four of the five explanations the time lag that maximizes the correlation coefficient between B_z and *AE* is found not to represent the time lag between an interplanetary cause and a consequent magnetospheric effect. It is shown that by simple extensions of the Foster et al. study, at least four of the five explanations can be eliminated. The implications of the Foster et al. study with regard to the 'growth phase controversy' are considered, and proposed extensions of the study appear likely to resolve the controversy. (auth)

3926 THE EXPANSIVE PHASE OF MAGNETOSPHERIC SUBSTORMS 2. THE RESPONSE AT SYNCHRONOUS ALTITUDE OF PARTICLES OF DIFFERENT ENERGY RANGES. Rostoker, G.; Kisabeth, J.L. (Institute of Earth and Planetary Physics, University of Alberta, Edmonton, Alberta, Canada); Sharp, R.D.; Shelley, E.G. J. Geophys. Res. 80: No. 25, 3557-3570 (1 Sept 1975).

Several previous studies have shown that there are variations in the energetic particle populations at synchronous orbit during periods of substorm activity; however, in these investigations the precise location of the satellite with respect to the longitudinal regime experiencing expansion phase activity has been unknown. In this paper, data from the Lockheed particle detectors on ATS 5 in synchronous orbit and from the meridian line of magnetometers operated by the University of Alberta are correlated for periods of substorm activity where the position of the satellite with respect to the expansion phase regime is known. It is found that changes in the nature of the energetic particle signatures at ATS 5 are correlated with changes in the auroral electrojet structure during the development of the substorm expansive phase. In particular, it is found that marked increases in the fluxes of the energetic particles showing no dispersion among the energy channels occur only when the satellite is on field lines which map to the poleward border of the substorm-intensified westward electrojet. It is further found that when the satellite is on field lines which penetrate the heart of the substorm westward electrojet, one only observes steady high fluxes of energetic particles, and there are no sharp well-defined changes in fluxes associated with continuing impulsive intensifications of the electrojet at its poleward border. It is concluded that the substorm disturbance typically begins at a given latitude and propagates poleward in impulsive steps and that energetic electron enhancements are observed at ATS 5 when the poleward border of the electrojet intensifies in the latitude range of the ATS field line foot. This fact permits the mapping of field lines in the geographic equatorial plane to the earth's surface at specific instants during the substorm expansion phase. (auth)

3927 FIELD-ALIGNED CURRENT FLOW ASSOCIATED WITH INTRUSION OF THE SUBSTORM-INTENSIFIED WESTWARD ELECTROJET INTO THE EVENING SECTOR. Rostoker, G. (Institute of Earth and Planetary Physics, University of Alberta, Edmonton, Alberta, Canada); Armstrong, J.C.; Zmuda, A.J. J. Geophys. Res. 80: No. 25, 3571-3579 (1 Sept 1975).

Previous studies have indicated that during substorm activity the westward electrojet penetrates into the evening sector poleward of the eastward electrojet. By use of magnetometer data from the polar-orbiting Triad satellite and ground-based magnetometer data it is shown that a region of intense upward field-aligned current flow encompasses the boundary between the eastward electrojet and the substorm-associated westward electrojet and that there is downward current flow both to the north and to the south of the boundary between the two electrojets. This result is interpreted in terms of the transition in electric field polarity at the boundary between the auroral oval and the polar cap reported by Cauffman and Gurnett (1971), and it is suggested that the substorm-associated westward electrojet extension into the evening sector is due primarily to conductivity enhancements and to a lesser extent to electric field enhancements. Evidence is shown that demonstrates the perturbation pattern observed at 800 km due to electrojet currents flowing in the ionosphere. It is suggested that double sheets of field-aligned currents may flow in the evening sector of the magnetotail during substorms. (auth)

3928 SPLASH ALBEDO PROTONS BETWEEN 4 AND 315 MeV AT HIGH AND LOW GEOMAGNETIC LATITUDES. Wenzel, K. (Space Science Department (ESLAB), European Space Research and Technology Centre, Noordwijk, Netherlands); Stone, E.C.; Vogt, R.E. J. Geophys. Res. 80: No. 25, 3580-3584 (1 Sept 1975).

The differential energy spectrum of splash albedo protons has been measured at high geomagnetic latitude near Fort Churchill, Manitoba, at three periods of the solar cycle in 1966, and 1969 and at low latitude near Palestine, Texas, in 1967 by using a balloon-borne solid state detector telescope. We observed splash albedo proton fluxes between 4 and 315 MeV of 81 ± 11, 70 ± 11, and 48 ± 8 protons/(m^2s sr) at high latitude in 1966, 1967, and 1969 and of 37 ± 9 protons/(m^2s sr) at low latitude in 1967. The decreases from 1966 to 1969 are due to solar modulation of the cosmic ray parent nuclei. The albedo spectrum shows a similar shape for both latitudes. The difference in intensity can be explained by different local geomagnetic cutoffs; i.e., a significant contribution to the splash albedo flux arises from primary particles with rigidity below 4.5 GV. The splash albedo flux near Fort Churchill is consistent with corresponding fluxes previously reported near 53°–55°N. The flux below 100 MeV near Palestine is significantly lower than that reported by Verma (1967). (auth)

3929 COSMIC-RAY OBSERVATION BY "SHINSEI". Spatial Distribution of Quasi-Trapped Electrons. Takeuchi, H.; Imai, T.; Wada, M.; Miyazaki, Y. (Institute of Physical and Chemical Research, Wako, Saitama (Japan)). Tokyo Daigaku Uchu Koku Kenkyusho Hokoku; 10: No. 3, pt.B, 667-676(Sep 1974). (In Japanese).

High energy electrons were observed with the satellite "Shinsei", and the analysis of the obtained data is in progress. A main detector used for the observation was a plastic scintillator. The axis of collimation was in a plane perpendicular to the spin axis of the satellite. The output pulses from the detector were analyzed by five integral type pulse height analyzers. The equi-intensity distribution in a B (magnetic field intensity) - L (shell parameter) diagram was obtained. The obtained data were compared with the

previous data by McIlwain, Tenny, and Paulikas-Blake-Freden, and the data are considered to be reasonable. The abnormal spatial distribution of electron intensity, which seemed to be due to temporary electron precipitation, was measured. The clear examples were seen over the sky above Caribbean Sea, Arabia and Pacific Ocean south-east of Japan. A few sharp peaks were seen in the distribution of low energy (> 400 keV) electrons, while high energy (> 1 MeV) electron distribution was nearly flat. From the loci and peak positions plotted in the B - L diagram, it was found that these peaks were observed at considerably lower height than the radiation belt, and the values of L of the peaks were mostly between 1.5 and 1.7. (TSS)

3930 NONLINEAR INTERACTION BETWEEN NORMAL WAVES IN MAGNETOACTIVE PLASMA WITH COLLISIONS. Kapel'zon, A. A.; Plotkin, V. V. (Inst. of Geology and Geophysics, Novosibirsk, USSR). Izv. Vyssh. Uchebn. Zaved., Radiofiz.; 18: No. 5, 625-629(1975). (In Russian).

It is shown that when normal waves interact with collisions in an anisotropic plasma, the conductivity of which depends on the electron temperature, the absorption of these waves and their polarization vary essentially due to the resonance. In this case spatial harmonics of the electron temperature disturbances with the wave vector equal to the difference of wave vectors of normal waves occur in plasma. The above-mentioned effect is comparable with the wave self-action and is absent only in longitudinal and transverse propagation. (auth)

3931 POTENTIAL OSCILLATIONS OF PLASMA MAGNETOPAUSE-TYPE LAYERS. Kovner, M. S.; Shkelev, E. I. (Gorky State Univ., USSR). Izv. Vyssh. Uchebn. Zaved., Radiofiz.; 18: No. 5, 656-662(1975). (In Russian).

Potential surface-type oscillations of a head part of the Earth magnetosphere is investigated for a homogeneous profile of the particle density in two cases when the directed particle velocity in the magnetopause is constant and when it is linearly changed in the direction of the normal to the magnetospheric boundary. In the first case the solution in the analytical form is obtained in the limit when the wavelength is much greater or lesser than the magnetopause width. The results of a numerical solution are also given for some definite parameter values relating to the first and the second cases. The oscillations are assumed to be of so high-frequency that the influence of the magnetic field may be neglected. (auth)

PHYSICS (ATOMIC AND MOLECULAR)

3932 (CONF-7206111-(Absts.)) TWENTY-SEVENTH SYMPOSIUM ON MOLECULAR STRUCTURE AND SPECTROSCOPY, COLUMBUS, OHIO, JUNE 12–16, 1972. Abstracts. (Ohio State Univ., Columbus (USA)). 1972. 212p. Ohio State Univ., Columbus.

Abstracts of 322 papers given at the symposium are presented along with a list of conference participants and the symposium program. (GHT)

Beams and Their Reactions

Refer also to abstracts 4055, 4514, 4526, and 4601.

3933 (UCID-16890) MOTION OF CHARGED PARTICLES IN PERIODICALLY VARYING MAGNETIC FIELDS. Rowlands, G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Aug 1975. Contract W-7405-Eng-48. 17p. Dep. NTIS $4.00.

A simple theory is developed to study the containment of charged particles in a periodic array of current carrying conductors. (auth)

3934 BEAM FORMATION IN MOLECULAR FLOW. Gottwald, B. A. (Technische Univ. Hannover (F. R. Germany). Inst. fuer Physikalische Chemie und Elektrochemie). pp 406–410 of Proceedings of the 4th International Symposium on the Molecular Beams. Cannes, France, 9-12 July 1973. Paris, France; Bartheye (1974).

From 4th international symposium on the molecular beams; Cannes, France (9 Jul 1973).

Comparison of experimental angular distribution data with theoretical models has shown a considerable disagreement with the Clausing model (free molecular flow with diffuse reflexion). For a real system this idealized model has to be modified by taking into consideration possible perturbations of the Clausing flow chemical reactions, surface diffusion and deviations from diffuse reflexion. By comparison with the diffusion differential equation and Monte Carlo stimulations, it has been shown that the iteration of a system of appropriately modified Clausing integral equations is especially suited for solving this complex problem. Suitable characterized parameters for angular distribution data are the beam half-width upsilon $\frac{1}{2}$ and the peaking factor χ defined according to Olander and Jones. The computer program in a first step calculates the real steady state of molecular flow. In a second step the computer program calculates the dependence of upsilon $\frac{1}{2}$ and χ upon the parameters L/2R (orifice geometry) and m′ (order of the surface reaction preceding the desorption from the inner wall of the cylindrical orifice), for the real steady state of molecular flow. (FR)

3935 ABSORPTION BANDS IN THE SECONDARY ELECTRONS CONTINUOUS SPECTRUM. Le Gressus, Claude; Massignon, Daniel (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Chimie-Physique). C. R. Hebd. Seances Acad. Sci., Ser. A. B; 280: No. 13, 401-404(7 Apr 1975). (In French)

Absorption edges in the secondary electrons continuous spectrum emitted by an electron irradiated target was observed. The energies of these absorption edges correspond exactly to those of the K, L, M, ... internal levels of the target atoms. Thus, it is possible to detect on a surface the existence of hydrogen atoms, which cannot possess any Auger transition, as well as the presence of the other elements, which is correlated to their Auger spectrum. (FR)

3936 BACKSCATTERING OF keV MOLECULAR HYDROGEN IONS FROM Au SURFACES. Eckstein, W.; Verbeek, H. (Max Planck Institut für Plasmaphysik, EURATOM Association, D-8046 Garching, Germany); Datz, S. Appl. Phys. Lett. 27: No. 10, 527-528 (15 Nov 1975).

Appreciable quantities of molecular hydrogen ions have been observed in backscattering of 5-keV D_3^+ from Au. At a scattering angle of 10° the D^+_2/D^+_1 ratio was 5×10^{-2} and $D^+_3/D^+_1=2\times10^{-4}$. The ratios decrease with increasing scattering angle, but D^+_2 is observable at angles up to 50°. (auth)

3937 PURE-STATE MOLECULAR BEAMS: PRODUCTION OF ROTATIONALLY, VIBRATIONALLY, AND TRANSLATIONALLY SELECTED CsF BEAMS. Bromberg, E.E.A.; Proctor, A.E.; Bernstein, R.B. (Chemistry Department, University of Wisconsin, Madison, Wisconsin 53706). J. Chem. Phys. 63: No. 8, 3287-3294 (15 Oct 1975).

Beams of CsF in selected vibrational (v=0,1,2,3,4) and rotational (J,M=1,0) states, with narrow velocity distributions, have been produced via an improved microwave molecular beam electric resonance (MBER) method utilizing "displacement focusing." The apparatus consists of an effusive graphite oven source, a slotted-disk velocity selector, and two electrostatic quadrupole fields. The first field focuses the $(J,M) = (2,0)$ state through an off-axis collimating orifice into a microwave cavity. Here microwave radiation stimulates the $J=2\rightarrow1$ transition for a specified v state. Then a second ("refocusing") quadrupole delivers the specified $(v,J,M) = (v,1,0)$ state to an image point (a collimated surface ionization mass filter detector). The final focused and state-selected beam, say (0,1,0), has a purity $\gtrsim 95\%$ with respect to J,M. However, the best over-all (v,J,M) state purity achieved was 83% (0,1,0), with 17% of "background" [of which 4% is actually (0,1,0), 4% is (1,1,0), 4% (v,1,0) with $v\geq2$, and the remaining 5% unselected (scattered) CsF]. Using the present effusive oven source, the best intensity achieved for a state-selected (0,1,0) beam (of velocity 3.65×10^4 cm sec^{-1}) was 1×10^5 molecule sec^{-1}, corresponding to a flux density of 1.3×10^9 molecule cm^{-2} sec^{-1}. (auth)

3938 STUDIES OF XENON ATOMS IN HIGH RYDBERG STATES. Stebbings, R.F.; Latimer, C.J.; West, W.P.; Dunning, F.B.; Cook, T.B. (Department of Space Physics and Astronomy, Rice University, Houston, Texas 77001). Phys. Rev. A 12: No. 4, 1453-1458 (Oct 1975).

Thermal beams of xenon atoms in single high Rydberg states have been produced by photoexcitation of $Xe(^3P_0)$ metastable atoms. The highly excited states which were populated in this way were identified as $np[1/2]_1$ with $11\leq n\leq16$ and $nf[3/2]_1$ with $8\leq n\leq40$. The field ionization characteristics and radiative lifetimes of these atoms have been studied. (auth)

3939 PROGRAMMABLE POWER SUPPLIES USEFUL FOR ELECTROSTATIC ANALYZERS. Ratcliffe, C.A. (Battelle Pacific Northwest Laboratories, Richland, Washington 99352). Rev. Sci. Instrum. 46: No. 11, 1586-1587 (Nov 1975).

Two voltage sources are described which can be used with electrostatic analyzers in automated ion–atom collision experiments. One is a 0 to −6 kV supply; the other is a dual (±) 0 to 300 V supply. Circuit diagrams are provided and accuracies discussed. (auth)

3940 QUANTUM THEORY OF SCATTERING OF ATOMS AND DIATOMIC MOLECULES BY SOLID SURFACES. Liu, W. S. Toronto; Univ. of Toronto (1973). vp. National Library of Canada, Ottawa.

Thesis (Ph. D.).

The quantum theory of scattering of atoms by solid surfaces, developed by Cabrera, Celli, Goodman, and Manson (Surface Science 19 (1970) 67), is extended to the scattering of particles having internal degrees of freedom by perfect harmonic crystalline surfaces. The diagonal matrix element of the interaction potential which enters into the quantum scattering theory is obtained to represent the potential for the specular beam. From the two-potential formula, the scattering intensities for the diffracted beams and the inelastic beams with or without internal transitions of the particles are obtained by solving the equation for the matrix elements. The unitary theory is extended in the following five areas: (1) elastic scattering (diffraction) of atoms in the absence of inelastic (phonon) scattering, (2) a combination of diffraction and inelastic scattering of atoms, (3) diffraction of diatomic molecules in the absence of inelastic scattering, (4) inelastic scattering of diatomic molecules in the absence of diffraction and (5) transition probabilities for atom-atomic oscillator collisions. The results are applied to experimental data on ^{4}He-LiF, H-LiF, H_2-LiF, D_2-LiF, H_2-W, D_2-W, and He-W systems. Qualitative agreement is found between theory and experiment. (Diss. Abstr. Int., B)

3941 REMEDIAL PULSE PROGRAMME FOR THE PRODUCTION OF MONOENERGETIC ION BEAMS OF LOW ENERGY. Olubuyide, O. A. Waltham, MA; Brandeis Univ. (1975). 272p. University Microfilms Order No. 75-15,119.

Thesis (Ph. D.).

The technique involves an extension of sequential pulse techniques. An ion swarm is produced in a conventional mass-spectrometer ion source by a short electron beam pulse. Immediately, this swarm is accelerated impulsively by a short high voltage pulse on the repeller. The principal disadvantage of impulsive acceleration is that the final energy distribution of the ion swarm is broad especially at the lowest energies. At some instant during the passage of the ion swarm across the chamber second pulse is applied to the repeller--a "remedial" pulse which will accelerate the ions throughout the remainder of their passage and whose ampli-

tude will be time-dependent. Slower ions must travel a greater distance in this "remedial" field than faster ions and will experience a proportionately greater increase in velocity from it. In this way, the remedial pulse can cause all the ions to acquire the same velocity at the exit slit. A limited experimental investigation has been made to examine the application of the proposed remedial pulse technique to existing ion sources. Application of the remedial pulse to impulsively-accelerated ion swarms reduced the energy distribution in the manner predicted by the theory but the quantitative reduction measured experimentally--a factor of approximately 2--was substantially less than the theoretical prediction of a factor of approximately 4. The limitations were characterized and a means of overcoming them was suggested in a new ion source of improved design. (Diss. Abstr. Int., B)

3942 ELECTRON BEAM GENERATING APPARATUS. Shinohara, K.; Shimizu, Y. (to Matsushita Electric Industrial Co. Ltd., Kadoma, Osaka (Japan)). Japanese Patent 1974-36474/B/. 1 Sep 1970. 3p. (In Japanese).

In an electron beam generating apparatus, the wire, plate or coil filament is supported by an anchor to prevent filament sag. The apparatus is arranged to heat the anchor by an electric current to prevent reduction of filament temperature by the anchor and to keep the electron beam uniform. (JA)

3943 ELECTRON BEAM GENERATING APPARATUS. Shimizu, Y. (to Matsushita Electric Industrial Co. Ltd., Kadoma, Osaka (Japan)). Japanese Patent 1974-36473/B/. 1 Jun 1970. 3p. (In Japanese).

An electron beam generating apparatus employing a linear, plate-like or coil type filament has an improved anchoring method to restrain filament sag and to prevent non-uniform electron beam distribution due to filament temperature reduction in the vicinity of the anchors. A separate filament is provided for applying heat to the anchors, to prevent them from absorbing heat from the electron emitting filament at the contact points. (JA)

3944 ELECTRON BEAM GENERATING DEVICE. Shinohara, K. (to Matsushita Electric Industrial Co. Ltd., Kadoma, Osaka, (Japan)). Japanese Patent 1974-36475/B/. 1 Sep 1970. 3p. (In Japanese).

A non-scanning electron beam generator has a linear filament welded at its ends to a molybdenum plate. The plate is connected to a conducting wire and suspended between springs for positioning the filament and for thermal expansion compensation. The distribution of emitted electrons is improved by a temperature compensating coil at the ends of the cathode filament. Deleterious effects upon electron distribution at the ends of the filament (which result from holding the temperature at the filament extremities below 1000°K to facilitate the action of the springs) can be essentially compensated for by the coils which emit more heat than the linear filament for a given current. The electrons are uniformly emitted across virtually the entire length of the filament. (JA)

3945 ELECTRON BEAM GENERATING DEVICE. Shinohara, K. (to Matsushita Electric Industrial Co. Ltd., Kadoma, Osaka (Japan)). Japanese Patent 1974-36476/B/. 1 Sep 1970. 3p. (In Japanese).

An electron beam generating apparatus employing a linear cathode filament has an improved anchoring method to curtail deformation of the filament while preventing a non-uniform electron beam distribution due to filament temperature reduction at the anchors. Two filaments are formed with a loop at each anchoring position, and each loop is fixed to and supported by its respective anchor. As a result, the thermal conductivity of the filament at the supported positions is not seriously affected by the anchors, creating a more uniform distribution of emitted electron beams. (TSS)

3946 CATHODOLUMINESCENCE OF SOME RARE EARTH IONS IN $GdAlO_3$ SINGLE CRYSTALS. Arsenev, PA. (Inst. of Energetics, Moscow); Hassan, H. W.; Chukichev, M. V. Phys. Status Solidi (a); 28: No. 2, K111-K115(16 Apr 1975).

Single crystals of $Gd_{0.95}R_{0.05}AlO_3$(R = Nd, Er, Ho, or Tm) were irradiated by short electron pulses (0.4 μs, 10 mA, 1A/cm², 40 keV) at 100°K. The luminescence spectra and decay were analyzed to determine the transitions, energy level schemes, and lifetimes for each R^{3+} ion. (DLC)

3947 ION SOURCE OF HIGH BRIGHTNESS USING LIQUID METAL. Krohn, V.E.; Ringo, G.R. (Argonne National Laboratory, Argonne, Illinois 60439). Appl. Phys. Lett. 27: No. 9, 479-481 (1 Nov 1975).

The beam from an EHD ion source using liquid gallium has been shown to have a brightness of 0.9×10^5 A $cm^{-2}sr^{-1}$ at 21 kV and an energy spread of 12 eV at 10-μA total current. The effective source diameter was 0.2 μm as imaged by a 2-cm-long Einzel lens with a 0.12-mm aperture. Cesium was significantly poorer and mercury much poorer than gallium. (auth)

3948 BACKSCATTERING OF He^+ AND H^+ PARTICLES FROM ULTRA-THIN FILMS IN THE ENERGY RANGE 50–100 keV. Goldberg, H.J.; Jack, H.E.; Dale, E.B. (Department of Physics, Kansas State University, Manhattan, Kansas 66506). Phys. Rev. A 12: No. 3, 908-910 (Sept 1975).

Elastic collision cross sections of He^+ and H^+ ions incident on Au, Ag, Cu, Bi, Ni, and In, of density equivalent to less than a monolayer of target material, have been measured in the energy range 50–100 keV by the measurement of particles backscattered through a laboratory angle of 150°. The results point to a Thomas-Fermi potential description of the collision process. (auth)

3949 EXCITED-STATE FORMATION AS H^+ AND He^+ IONS SCATTER FROM METAL SURFACES. Baird, W.E.; Zivitz, M.; Thomas, E.W. (School of Physics, Georgia Institute of Technology, Atlanta, Georgia 30332). Phys. Rev. A 12: No. 3, 876-884 (Sept 1975).

Impact of 10-to 30-KeV H^+ or He^+ ions on polycrystalline metal surfaces causes some projectiles to be backscattered in a neutral excited state. These projectiles subsequently radiatively decay, emitting Doppler-broadened spectral lines. By analysis of the spectral shape of these lines, we are able to determine the probability of radiationless deexcitation of the excited backscattered atoms. Quantitative measurements of spectral intensity indicate that less than 1% of all projectiles are backscattered in an excited state. The relative variation of total spectral line intensity with angle of projectile incidence and with projectile primary energy has been successfully predicted using a model which assumes that the probability for excited-state formation is independent of the scattered projectile's energy and direction. We also predict the variation in total spectral line intensity with target atomic number. Finally, we examine briefly the sputtering and excitation of Al under He^+ impact. (auth)

3950 BEAM–FOIL SPECTROSCOPY OF NEON BETWEEN 80 AND 350 Å. Buchet, J.P.; Druetta, M. (Laboratoire de Spectrométrie Ionique et Moléculaire (associé au C.N.R.S.), Université Claude Bernard, Lyon I, 43, bd du 11 novembre 1918, 69621–Villeurbanne, France). J. Opt. Soc. Am. 65: No. 9, 991-994 (Sept 1975).

Beam-foil spectra of the different neon ions Ne III–Ne VII have been studied between 80 and 350 Å at a beam energy of 2 and 1 MeV. Mean lives of excited levels have been measured. New lines in Ne V are identified as transitions from the $2s^22p3p$ (^3S ^3P ^3D) terms, for which the term energies are deduced. (auth)

3951 CALCULATED ENERGY DISTRIBUTIONS FOR LIGHT 0.25–18-keV IONS SCATTERED FROM SOLID SURFACES. Robinson, J.E.; Harms, A.A.; Karapetsas, S.K. (Department of Engineering Physics, and Institute for Materials Research, McMaster University, Hamilton, Ontario, L8S 4M1, Canada). Appl. Phys. Lett. 27: No. 8, 425-427 (15 Oct 1975).

Scattered energy distributions are calculated for light ions incident on Nb and Mo surfaces of interest for controlled nuclear fusion reactors. The scattered energy is found to vary as a function of the reflection coefficient between a multiple-collision limit at low energies and a single-collision Rutherford scattering limit at high energies. High-energy peaking of the scattered particle distributions is also found for low incident energies. (auth)

3952 AUGER ELECTRON SPECTROSCOPY IN SPUTTERING MEASUREMENTS: APPLICATION TO LOW-ENERGY Ar^+ SPUTTERING OF Ag AND Nb. Smith, J.N. Jr.; Meyer, C.H. Jr.; Layton, J.K. (General Atomic Company, San Diego, California 92138). J. Appl. Phys. 46: No. 10, 4291-4293 (Oct 1975).

The sputtering of Ag and Nb by Ar^+ in the energy range from 0.5 to 1.5 keV has been measured. The agreement with extant data, where available, is good. The experimental technique is a new adaptation of certain earlier methods and employs Auger electron spectroscopy of a continuously sputtered area of a thin-film composite structure, produced by vapor deposition. This new method should permit very low sputter yields ($S \lesssim 10^{-3}$) to be measured in subsequent experiments. (auth)

3953 STOPPING CROSS SECTIONS FOR 0.25–3.0-MeV ^4He IONS IN CADMIUM SULFIDE. Miller, W.E.; Hutchby, J.A. (NASA-Langley Research Center, Hampton, Virginia 23665). J. Appl. Phys. 46: No. 10, 4479-4482 (Oct 1975).

Stopping cross sections of ^4He ions with energies 0.25–3.0 MeV have been measured for cadmium sulfide with a probable error of ±7–8%. The experimental method utilized the Rutherford backscattering technique and measured the energy loss of elastically scattered ^4He ions from films of cadmium sulfide sputtered on carbon substrates. The experimental data are compared to recent experimental and theoretical results. (auth)

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Refer also to abstracts 3988, 4035–4038, 4044, and 4061.

3954 (LBL-4000, pp 325-327) MULTIPLET SPLITTING OF THE 4s AND 5s CORE LEVELS IN THE RARE EARTH METALS. McFeely, F. R.; Kowalczyk, S. P.; Ley, L.; Shirley, D. A. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

3955 (UCLA-34P88-36) INTRA- AND INTER-MOLECULAR ENERGY TRANSFER STUDIES. Progress Report, 1 June 1974–31 May 1975. Nicol, M. F. (California Univ., Los Angeles (USA). Dept. of Chemistry). 15 Jul 1975. Contract E(04-3)-34. 29p. Dep. NTIS $4.50.

The analysis of pressure-induced effects on the intersystem crossing in anthracene; determination of the influence of hydrogen-bonding on the intersystem crossing rate and phosphorescence of azines; experimental studies of the kinetics of high-pressure structural transitions in Teflon; testing of liquid helium temperature high-pressure optical cells; excimer production in compound crystalline aromatic hydrocarbons; and studies of the structure and chemistry of dianthracene at high pressures are described. (6 figs.) (GHT)

3956 SELF-CONSISTENT TIME-DEPENDENT HARTREE-FOCK CALCULATIONS OF DYNAMIC POLARIZABILITIES, DISPERSION FORCES, AND NUCLEAR SPIN-SPIN COUPLING CONSTANTS FOR THE H_2 AND HF MOLECULES. Oddershede, J.; Jørgensen, P.; Beebe, N.H.F. (Department of Chemistry, Aarhus University, DK-8000 Aarhus C., Denmark). J. Chem. Phys. 63: No. 7, 2996-3007 (1 Oct 1975).

We present a self-consistent time-dependent Hartree–Fock scheme for calculating excitation frequencies, oscillator strengths, dynamic polarizabilities, dispersion forces, and indirect nuclear spin–spin coupling constants. *Ab initio* applications on the H_2 and HF molecules have been performed. The effect of two-particle, two-hole excitation corrections are included. The results show that the method offers an accurate and economical alternative to configuration interaction for introducing correlation in second order properties. The spin–spin coupling constants, which depend on the triplet excited states, are most influenced by the self-consistency procedure. (auth)

3957 RELATIVE AND ABSOLUTE LEVEL POPULATIONS IN BEAM-FOIL–EXCITED NEUTRAL HELIUM. Davidson, J. (Department of Physics, University of Arizona, Tucson, Arizona 85721). Phys. Rev. A 12: No. 4, 1350-1357 (Oct 1975).

Relative and absolute populations of 19 levels in beam-foil–excited neutral helium at 0.275 MeV have been measured. The singlet angular-momentum sequences show dependences on principal quantum number consistent with n^{-3}, but the triplet sequences do not. Singlet and triplet angular-momentum sequences show similar dependences on level excitation energy. Excitation functions for six representative levels were measured in the range 0.160 to 0.500 MeV. The absolute level populations increase with energy, whereas the neutral fraction of the beam decreases with energy. Further, the *P* angular-momentum levels are found to be overpopulated with respect to the *S* and *D* levels. The overpopulation decreases with increasing principal quantum number. (auth)

3958 PROTON KINETIC-ENERGY DISTRIBUTIONS FROM DISSOCIATIVE PHOTOIONIZATION OF HYDROGEN. Gardner, J.L.; Samson, J.A.R. (Behlen Laboratory of Physics, University of Nebraska, Lincoln, Nebraska 68508). Phys. Rev. A 12: No. 4, 1404-1407 (Oct 1975).

Measurement of proton kinetic-energy distributions from dissociative photoionization of H_2 is reported, for incident-photon energies up to 41 eV. Data are presented for transitions involving the $1s\sigma_g$ ground state and higher states of H_2^+. At a photon energy of 41 eV, direct ionization involving the $2p\sigma_u$ state accounts for approximately one-half of the dissociative ionization; other processes, autoionization or direct ionization involving states of higher energy than $2p\sigma_u$ account for the remainder. (auth)

3959 FINE STRUCTURE OF RYDBERG STATES: $n=6$ AND 7 *D* AND *F* STATES OF ^{4}He. MacAdam, K.B. (Department of Physics, University of Arizona, Tucson, Arizona 85721); Wing, W.H. Phys. Rev. A 12: No. 4, 1464-1474 (Oct 1975).

We have measured all the fine-structure intervals in the configurations $1s7d$ and $1s7f$ of ^{4}He as well as the intervals $6\,^1D_2$-$6\,^1F_3$ and $6\,^1D_2$-$6\,^3F_3$ by a microwave-optical-resonance method. The level of accuracy considerably exceeds that of available calculations. We discuss the results in relation to the breakdown of *LS* coupling, and we estimate the singlet-triplet mixing coefficients and the corresponding level perturbations. We obtain an improved fitting formula useful for predicting the frequencies of $n\,^1D_2$-$n\,^{1,3}F_3$ transitions. (auth)

3960 *K*-SHELL X-RAY PRODUCTION CROSS SECTIONS OF SELECTED ELEMENTS Ti TO Sb FOR 1.0- TO 5.0-MeV/amu ^{7}Li IONS. McDaniel, F.D.; Gray, T.J.; Gardner, R.K.; Light, G.M.; Duggan, J.L. (Department of Physics, North Texas State University, Denton, Texas 76203); Van Rinsvelt, H.A.; Lear, R.D.; Pepper, G.H.; Nelson, J.W.; Zander, A.R. Phys. Rev. A 12: No. 4, 1271-1280 (Oct 1975).

K-shell x-ray production cross sections for thin targets of selected elements Ti to Sb have been measured for ^{7}Li ions in energy steps of 0.2 MeV/amu in the range from 1.0 to 5.0 MeV/amu. Comparisons of the cross-section data for the lighter elements ($Z_2 \leq 28$) to the plane-wave Born approximation (PWBA) and the PWBA corrected for binding energy and Coulomb deflection show that the data are best represented at the lower energies by the corrected PWBA and approach the PWBA at the higher energies. When approximate relativistic corrections are made to the theories for the heavier elements studied, the same general trend is observed. Calculation of the ratio $R=\sigma\ (Z_1)/Z_1^2\sigma\ (Z_1=1)$ supports the inclusion of binding-energy and Coulomb deflection corrections to the PWBA at the lower ion energies. The corrections to the PWBA, while improving the fit to the data, underestimate the cross sections by 10–100% in all cases. The $K\beta/K\alpha$ ratios are found to be in good agreement with theoretical estimates assuming single-hole ionization. (auth)

3961 IMPROVEMENT TO WAVE FUNCTIONS AND ENERGY VALUES OF THE GROUND STATE OF HELIUM. Radi, H.M.A. (Department of Physics, University of Kuwait, Kuwait). Phys. Rev. A 12: No. 4, 1137-1143 (Oct 1975).

Nonrelativistic wave functions and energy values for the ground state of helium are calculated accurately by using the conventional Rayleigh-Ritz technique. However, the trial wave functions used are more general than those used by Hylleraas and others. They contain interelectronic separation coordinates in the exponential function beside the variational parameters. Groups of three- and four-parameter wave functions are obtained with comparatively smaller energies. Also, improved wave functions and energies have been obtained by solving determinants of orders 7, 13, 22, 34, 50, 70, 95, and 125, using a simple model. The last determinant yields an energy value of −2.903724371 a.u., as compared with −2.903724370 a.u. obtained by Pekeris by solving a determinant of order 715. The first determinant (ten parameters) yields an energy value of −2.903425858 a.u., as compared with the recent value of −2.9022 a.u. computed by Tweed with the use of a 41-parameter wave function. (auth)

3962 CORE RADIAL POLARIZATION AND THE CONTACT HYPERFINE STRUCTURE OF ^4S STATE OF NITROGEN. Ishida, K. (Department of Hydrocarbon Chemistry, Faculty of Engineering, Kyoto University, Kyoto, Japan). Phys. Rev. A 12: No. 4, 1153-1158 (Oct 1975).

The contact hyperfine structure constant for the ^4S state of the nitrogen atom is computed variationally by a multiconfiguration self-consistent-field method. The present calculations take account of radial-correlation contributions to the spin density, but do not take account of any significant part of angular correlations. It is found that the calculated value of 0.0977 for the spin density is in excellent agreement with the experimental value of 0.0972. A mechanism called "core radial polarization," for providing contributions mainly to the spin density at the nucleus, is proposed. It is noted that the mechanism provides a main contribution for the ^4S state of nitrogen as well as for the ^2P state of lithium. It is also claimed that the proper description of radial correlations should be a prerequisite for a good spin density. (auth)

3963 NATURE OF THE EXCITED STATES OF He_2. Guberman, S.L.; Goddard, W.A. III (Arthur Amos Noyes Laboratory of Chemical Physics, California Institute of Technology, Pasadena, California 91125). Phys. Rev. A 12: No. 4, 1203-1221 (Oct 1975).

The low-lying excited states of He_2 have been examined using spatially projected generalized-valence-bond wave functions. Typically the excited-state potential curves are repulsive at large R (internuclear distance) but exhibit an attractive well at small R. We find that the repulsion at large R results from an unfavorable exchange interaction of a Rydberg orbital mostly on one He with the two core orbitals on the other He. This arises from the restrictions on the molecular wave function implicit in the Pauli principle and is similar in nature to the repulsive pair-pair interactions between ground-state He atoms. For $R < 3a_0$ the Rydberg orbital is large compared with R and the shape of the potential curve is determined by core-core interactions. For the $A\,^1\Sigma_u^+$ state, the calculated maximum in the potential curve is 0.0607 eV at 3.09 Å, in excellent agreement with experimentally derived values. Results are presented for several other excited states. (auth)

3964 ROTATIONAL ENERGY RELAXATION IN MOLECULAR HYDROGEN. Rabitz, H. (Department of Chemistry, Princeton University, Princeton, New Jersey 08540); Lam, S. J. Chem. Phys.. 63: No. 8, 3532-3542 (15 Oct 1975).

Theoretical studies of rotational relaxation in para-hydrogen are presented. By using a set of theoretically deduced state-to-state rotational

rate constants the master kinetic equations and the relevant fluid mechanical equations are solved numerically. Calculations are performed over the range $100 \leq T \leq 1100$°K to simulate conditions for free jet expansion, shock tube, and sound absorption experiments. The over-all rotational energy relaxation rates extracted from these calculations are compared with available experimental data and are shown to be in good qualitative agreement. The magnitudes and the temperature dependence of these rates depend critically on the degree and direction of the initial departure from equilibrium as well as the multilevel nature of the relaxation process. The apparent discrepancies in the measured rates from the different experiments are shown to be qualitatively self-consistent in light of the present calculations. (auth)

3965 NONEQUILIBRIUM VELOCITY DISTRIBUTIONS AND RECOMBINATION RATES IN ELECTRON–ION AND ION–ION RECOMBINATIONS IN WEAKLY IONIZED GASES. Koura, K. (National Aerospace Laboratory, Chofu, Tokyo, Japan). J. Chem. Phys. 63: No. 8, 3302-3306 (15 Oct 1975).

The nonequilibrium velocity distributions and recombination rates in electron–ion and ion–ion recombinations in a heat bath of neutral molecules are investigated by solving the Boltzmann equation with the Monte Carlo simulation. The explicit time-dependent velocity distributions and recombination rates from the initial equilibrium to quasisteady states are obtained for the typical electron–ion dissociative recombination $e+N^+_2 \rightarrow N+N$ in the heat bath of N_2 and for the typical ion–ion recombination $H^+ + H^- \rightarrow H+H$ in the heat bath of H_2. The velocity distributions and the recombination rates indicate significant deviations from equilibrium. The decreases in the recombination rates from the equilibrium rates are 30% for $e+N^+_2 \rightarrow N+N$ and 15% for $H^+ + H^- \rightarrow H+H$ at quasisteady states for the heat bath temperature 300°K and the charge concentrations $X \sim 10^{-4}$ and 10^{-2}, respectively. The Monte Carlo result is compared with the Chapman–Enskog solution by Shizgal and Karplus for $H^+ + H^- \rightarrow H+H$. The Chapman–Enskog solution indicates a too large nonequilibrium for high charge concentration $X > 10^{-4}$. (auth)

3966 FREQUENCY SHIFT OF HYPERFINE TRANSITION $\Delta m_F = 0$ OF THE GROUND STATE OF AN H ATOM CHEMICALLY INTERACTING WITH MOLECULES IN THE GAS PHASE. Gordon, E.B.; Ivanov, B.I.; Perminov, A.P.; Balalaev, V.E.; Datchenko, F.F.; Ponomarev, A.N. (Institute of Chemical Physics, USSR Academy of Sciences). JETP Lett. 21: No. 11, 309-310 (5 June 1975).

We have observed experimentally large frequency shifts of the hyperfine transition ($\lambda = 21$ cm) of the H atom, due to its chemical interaction with CO and SO_2 molecules in the gas phase. The effect is attributed to the abrupt decrease of the hyperfine splitting in the short-lived intermediate complex. (auth)

3967 NEW EXPERIMENTAL OBSERVATIONS IN THE COLLISION-INDUCED INFRARED SPECTRA OF MOLECULAR HYDROGEN. Chang, K. S. St. John's, Newfoundland; Memorial Univ. of Newfoundland (1974). vp. National Library of Canada, Ottawa.

Thesis (Ph. D.).

Several new experimental observations in the collision-induced infrared absorption spectra of molecular hydrogen at liquid nitrogen and room temperatures for densities up to 660 amagat are described. The spectral region investigated extends from 3500 to 10,000 cm^{-1}. Collision-induced vibration-rotation U transitions ($\Delta J = +4$) of the hydrogen molecule in its fundamental band have been observed for the pure gas and for the binary mixtures, hydrogen-xenon, and hydrogen-krypton. The high frequency tail of the quadrupolar S transitions which overlaps the U transitions has been separated from the experimental profiles. The spectrum of the U transitions is interpreted in terms of the hexadecapolar induction mechanism. From the experimental integrated binary absorption coefficients of the U transitions, appropriate values of the hexadecapole moment matrix elements of the hydrogen molecule are derived. Spectra of the collision-induced first overtone band of hydrogen in binary mixtures with krypton and xenon have been recorded for the first time. From an analysis of the profiles of the enhancement of absorption, the frequency shifts Δ^v_0 and the half-widths δ have been determined. The observed half-widths of the quadrupolar lines were found to increase with the density of the inert gas. (Diss. Abstr. Int., B)

3968 TENSOR POLARIZABILITY OF THE 2^1P_1 STATE OF HELIUM AND THE CASCADE HANLE EFFECT STUDY IN NEON. Bhaskar, N. D. New York; Columbia Univ. (1974). 182p. University Microfilms Order No. 75-5203.

Thesis (Ph. D.).

Measurements in atomic helium of the tensor polarizability of the $2\ ^1P_1$ state have been made and are excellent agreement with the theory. From these measurements the tensor polarizability, $alpha_2(2\ ^1P_1)$, of the $2\ ^1P_1$ state is found to be $(3.32 \pm 0.10) \times 10^{-23}$ cm^3. Measurements in atomic neon of the radiative lifetimes of the excited states $2p_{10}(^3S_1)$, $2p_8(^3D_2)$ and $2p_5(^1P_1)$ of the $2p^53p$ series and the resonance levels $1s_4(^3P_1)$ and $1s_2(^1P_1)$ of the $2p^53s$ series have been made using the cascade Hanle effect technique. From these measurements the lifetimes (pi) of the excited states and the resonance levels are found to be tau$(2p_{10})$ equals $(20.08 \pm .97) \times 10^{-9}$ sec., tau(2p) equals $(11.52 \pm .73) \times 10^{-9}$ sec., tau$(2p_8)$ equals $(26.43 \pm 1.02) \times 10^{-9}$ sec., tau$(1s_4)$ equals $(27.62 \pm 1.03) \times 10^{-9}$ sec., and tau$(1s_2)$ equals $(2.46 \pm .32) \times 10^{-9}$ sec. (Diss. Abstr. Int., B)

3969 QUANTUM ELECTRODYNAMIC CORRECTIONS TO THE $2^3S_1 - 1^1S_0$ TRANSITION RATE IN HELIUM AND HELIUM-LIKE IONS. Kelsey, E. J. College Park, MD; Univ. of Maryland (1974). 122p. University Microfilms Order No. 75-7342.

Thesis (Ph. D.).

A number of corrections to the lowest order 2^3S_1 lifetime are examined. The O(Z alpha)[5] and O alpha(Z alpha)[4] energy denominator and recoil corrections to the leading O(Z alpha)[4] transition amplitude are considered. O alpha(Z alpha)[4] terms arise in the individual diagrams, but they cancel upon summation. The 1/Z correction from the interaction of the electrons is computed exactly by employing Schwinger's integral representation for the Coulomb Green's function. This analytically derived 1/Z correction checks very well with the value obtained by Drake through a variational procedure. (Diss. Abstr. Int., B)

3970 MEASUREMENT OF THE FINE STRUCTURE OF He $He_2(a^3SIGMA/sub\ u/^+)$. Vierima, T. L. New Haven; Yale Univ. (1974). 116p. University Microfilms Order No. 75-15,380.

Thesis (Ph. D.).

The fine structure of the N equals 1 and N equals 3 levels of the He_2 molecule in the $a^3SIGMA^+/sub\ u/$ state has been measured and is in reasonable agreement with estimates based on a simple model. The negligible contribution of the off-diagonal spin-orbit interaction in this state made it an excellent subject for the study of the spin-spin interaction. (Diss. Abstr. Int., B)

3971 TIME-ORDERED UNIFIED CLASSICAL PATH THEORY OF STARK BROADENING: APPLICATION OF He II. Greene, R. L. Boulder, CO; Univ. of Colorado (1974). 213p. University Microfilms Order No. 75-13,429.

Thesis (Ph. D.).

The problem of Stark broadening in singly ionized helium is examined in the context of the Unified Classical Path Theory of Smith, Vidal, and Cooper. The previously neglected time-ordering of the time development operator is included by means of a technique adapted to line broadening by Lisitsa and Sholin. The technique is used in a one-electron calculation of the Lyman-alpha line of hydrogen and the results compared with two previous time-ordered calculations. One manifestation of the Coulomb attraction between charged radiators and perturbing electrons occurs in the quasi-static limit where it is shown that, in contrast to previous predictions, the electron contribution to the wings of charged radiator lines is proportional to DELTA omega/sup -9/4/ rather than DELTA omega/sup -5/2/. Detailed calculations were performed for the Lyman-alpha line of He II. Comparison of the time-ordered results with similar results which neglect time-ordering shows that inclusion of time-ordering causes a reduction in the intensity in line center and an increase in the half-width of the line. Finally, some suggestions are made with regard to future time-ordered Unified calculations. (Diss. Abstr. Int., B)

3972 ATOMIC TRANSITION PROBABILITIES FOR SCANDIUM AND TITANIUM: A CRITICAL DATA COMPILATION OF ALLOWED LINES. Wiese, W. L.; Fuhr, J. R. (National Bureau of Standards, Washington, DC). J. Phys. Chem. Ref. Data; 4: No. 2, 263-352(1975).

Atomic transition probabilities for about 1500 allowed spectral lines of the elements scandium and titanium through all stages of ionization have been critically evaluated and compiled. All available literature sources have been utilized. The data are presented in separate tables for each element and stage of ionization and are arranged according to multiplets and, when appropriate, also to transition arrays and increasing quantum numbers. For each line the transition probability for spontaneous emission, the absorption oscillator strength, and the line strength are given along with the spectroscopic designation, the wavelength, the statistical weights, and the energy levels (when available) of the upper and lower atomic states. In addition the estimated accuracy and the literature reference is indicated. In short introductions, which precede the tables for each spectrum, the main justifications for the choice of the adopted data and for the accuracy rating are discussed. A general introduction contains some more details on our evaluation procedure. (auth)

3973 ABSOLUTE ELASTIC DIFFERENTIAL ELECTRON SCATTERING CROSS SECTIONS IN THE INTERMEDIATE

ENERGY REGION. I. H_2. Srivastava, S.K.; Chutjian, A.; Trajmar, S. (Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California 91103). J. Chem. Phys. 63: No. 6, 2659-2665 (15 Sept 1975).

A new method for measuring absolute electron-impact differential cross sections (DCS) for elastic scattering in gases is described. The technique uses a well-defined crossed-beam scattering geometry in which the relative target densities of an unknown and a secondary standard gas are accurately determined by a calibrated flowmeter and a pressure gauge. The method is applied to the measurement of elastic scattering from H_2 (which, in the present work, also includes rotational excitation) relative to elastic scattering from He, the secondary standard. The relative DCS for H_2 are then placed on the absolute scale by using recently measured absolute elastic DCS for He. Measurements for H_2 are reported at incident electron energies of 3–75 eV, and in the angular range 20°–135°. Differential and integral cross sections at each energy are compared with previous measurements and recent theoretical calculations. (auth)

3974 SEMICLASSICAL TRANSITION STATE THEORY FOR NONSEPARABLE SYSTEMS: APPLICATION TO THE COLLINEAR $H+H_2$ REACTION. Chapman, S.; Garrett, B.C.; Miller, W.H. (Department of Chemistry and Inorganic Materials Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). J. Chem. Phys. 63: No. 6, 2710-2716 (15 Sept 1975).

Two different kinds of semiclassical approximations are used to evaluate a previously obtained quantum mechanical transition state theory rate expression. No assumptions, however, such as separability of the Hamiltonian, vibrationally adiabatic motion along a reaction coordinate, etc., are incorporated. Application is made to the collinear $H+H_2$ reaction, and agreement with accurate quantum scattering calculations is found to be reasonably good. The results indicate that transition state theory—provided no assumptions of separability are included—is probably as accurate quantum mechanically as it has been found to be classically for describing the threshold of chemical reactions with an activation barrier. (auth)

3975 VARIATIONAL CALCULATION OF THE SINGLE-PARTICLE DENSITY MATRIX AND MOMENTUM DENSITY FOR THE HELIUM GROUND-STATE ISOELECTRONIC SEQUENCE. Sahni, V. (The New School of Liberal Arts, Brooklyn College of the City University of New York, Brooklyn, New York 11201); Krieger, J.B.; Gruenebaum, J. Phys. Rev. A 12: No. 3, 768-775 (Sept 1975).

A recently developed variational formalism for the determination of the reduced single-particle density matrix, correct to second order, is applied to the ground state of the helium isoelectronic sequence. For a Slater-determinant–type trial wave function the method requires the initial determination of either the charge density or equivalently its cosine Fourier transform for spherically symmetric systems. The trial wave function employed is a one-parameter Hartree product of hydrogenic functions and use is made of the highly accurate analytic expressions derived elsewhere for the Fourier transform of the charge density for the helium sequence. Analytic expressions for the single-particle density matrix are obtained and the internal self-consistency of the technique with regard to the Kato cusp condition is discussed. These expressions are then employed to obtain closed form analytic expressions for the momentum density valid for the entire isoelectronic sequence. These results are subsequently employed to obtain expressions for the expectation values of the operators p^4, p^2, $|p|$, and $|p|^{-1}$ and the Compton profile in the impulse approximation. Analytic Hartree-Fock calculations for these properties are also performed, and the results of the variational calculation are compared with these results and those of many-parameter correlated wave-function calculations wherever possible. It is observed that the results of the single-parameter variational calculation for helium are highly accurate and improve further for each heavier element of the isoelectronic sequence. (auth)

Positronium, Muonium, and Muonic and Mesic Atoms and Molecules

Refer also to abstract 4079.

3976 CORRECTION TO MUONIC X—RAY SPECTRA FOR NUCLEAR POLARIZATION AND EXTENDED SPACE. McLoughlin, D.; Raboy, S. (Department of Physics, State University of New York at Binghamton, Binghamton, New York 13901); Deci, E. Phys. Rev. Lett. 35: No. 15, 983-985 (13 Oct 1975).

The nuclear-polarization and extended-space corrections are calculated for x-ray transitions of muonic atoms of ^{169}Tm, ^{181}Ta, and ^{165}Ho for acceptable values of the three parameters: the half-radius of the charge distribution, the surface thickness, and the intrinsic quadrupole moment. It is shown that there is enough variation in the values of the corrections for the transitions in a given nuclide to preclude the assignment of a constant amount to all the transitions. (auth)

3977 PHOTON PROPAGATION IN NUCLEAR MATTER AND THE CORRECTION TO THE THEORETICAL NUCLEAR CHARGE DENSITY. Tanabe, K. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544). Phys. Rev. C 12: No. 4, 1346-1353 (Oct 1975).

The polarization function is derived for a virtual photon propagating in uncorrelated nuclear matter. The modification of the photon propagator and the induced charge distribution in the presence of the external field source are expressed in terms of a finite effective photon mass which is dependent on the Fermi momentum. The application is made to a finite nucleus by subtracting the local field due to the surrounding infinite matter distribution. It is found that the correction to the potential due to the scattering of exchanged virtual photons by the nucleus results in a short range repulsive force on the orbiting muon in muonic atoms. The estimated energy shifts are −560 eV for the $2p_{1/2}\rightarrow 1s_{1/2}$ transition, and −291 eV for the $3d_{5/2}\rightarrow 2p_{3/2}$ transition in ^{208}Pb; and −58 eV and −2.5 eV, respectively, in ^{90}Zr. The effects are negligible for higher orbits. (auth)

3978 I. MUONIUM FORMATION IN NOBLE GASES AND NEGATIVE MUON POLARIZATION IN HELIUM. II. Precision Eight-Order Solenoid. Stambaugh, R. D. New Haven; Yale Univ. (1974). 180p. University Microfilms Order No. 75-15,377. Thesis (Ph. D.).

Part One: The percentage of stopped muons forming muonium in helium, neon, argon, and xenon was measured to provide a more complete understanding of the formation process and useful information for studies of stopped muons and muonium in the noble gases. No muonium was observed in helium or neon. In argon, 65 percent muonium formation was observed. More than 50 percent muonium formation was observed in xenon, but the results were complicated by the presence of gas impurities which depolarized the muonium. Only 10 percent (+-5 percent) free muons were observed in the xenon which implies at least 90 percent formation of muonium. Formation percentages of 17 percent in helium + 0.015 percent xenon, 75 percent in helium + 0.092 percent xenon, and 81 percent in neon + 0.15 percent xenon were measured. The mixture results demonstrate electron capture at low muon kinetic energies from xenon, the only noble gas for which electron capture is energetically allowed at all energies. The fact that the muonium formation was less than 100 percent in the mixtures implies either an extremely low electron capture cross section from xenon at thermal energy or the abundant formation of the molecular ions $(mu^+He)^+$ and $(mu^+Ne)^+$ at a few eV muon kinetic energy. A search was made for the formation of the atom (alpha mu^-e^-). An upper limit of 4.4 percent was set for the residual polarization of the negative muons stopped in pure helium gas. Xenon was added to the pure helium to promote the reaction $(alpha\ mu^-)^+ + Xe$ yields $(alpha\ mu^-e^-) + Xe^+$. No evidence was found for the formation of (alpha mu^-e^-). Part Two: A precision eighth-order solenoid magnet (PIPS) was constructed to enable the observation of strong field muonium resonance lines by sweeping the magnetic field. (Diss. Abstr. Int., B.)

3979 REACTION OF ORTHO-POSITRONIUM WITH NITRO-AROMATICS VIA COMPLEX FORMATION. Madia, W. J. Blacksburg, VA: Virginia Polytechnic Inst. and State Univ. (1975). 197p. University Microfilms Order No. 75-15,879. Thesis (Ph. D.).

A study was made to ascertain the mechanism by which ortho-positronium reacts with nitroaromatics in solution. These reactions are two to three orders of magnitude faster than expected by simple pickoff. Conjugation of the nitro group with the aromatic ring was found to be a necessary condition for this behavior. The rate constant for each of these reactions was measured in suitable solvents over a wide temperature range, 200-500°K. Distinct departure from the Arrhenius law was found. In general, the rate constant increased linearly with increasing temperature up to a point, and then decreased linearly as the temperature was raised further. Ortho-positronium reacts with the nitroaromatic to form a complex in a reversible step. The complex may either decompose into a positronium atom and nitroaromatic molecule or it may go on to annihilate the positron. An approximate molecular orbital study has been made to study the possible existence of positron and positronium complexes with a select number of organic molecules. The CNDO/2 approximation is used for all electronic integrals and for electron positron Coulomb integrals. The core Hamiltonian matrix elements for the positron were estimated by combining the Wolfsberg-Helmholtz and Cusachs-Cusachs approximations. This approach shows that the positron should become bound to the molecules. Using the same criteria, the formation of stable positronium complexes is more improbable. The calculated

binding energies are strongly dependent on the value of Wolfsberg-Helmholtz proportionality constant for positrons. (Diss. Abstr. Int., B)

3980 TEMPERATURE DEPENDENCE OF POSITIVE-MUON PRECESSION FREQUENCY IN GADOLINIUM. Gurevich, I. I.; Klimov, A. I.; Maiorov, V. N.; Meleshko, E. A.; Nikol'skii, B. A.; Pirogov, A. V.; Roganov, V. S.; Selivanov, V. I.; Suetin, V. A. JETP Lett. (USSR) (Engl. Transl.); 21: No. 1, 7-8(5 Jan 1975).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 21: No. 1, 16-19(5 Jan 1975).

It is shown that at 230-280°K the temperature dependence of the precession frequency of positive muons in gadolinium is not described by a Brillouin function. An estimate $P_e > 0.04$ is presented for the polarization of the conduction electrons in gadolinium. (auth)

3981 MEASUREMENT OF POSITIVE-MUON SPIN-PRECESSION PHASE SHIFT. Kudinov, V. I.; Minaichev, E. V.; Myasishcheva, G. G.; Obukhov, Yu. V.; Roganov, V. S.; Savel'ev, G. I.; Samoilov, V. M.; Firsov, V. G. (Inst. of Theoretical and Experimental Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 21: No. 1, 22-23(5 Jan 1975).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 21: No. 1, 49-51(5 Jan 1975).

The modulus and the initial phase of the vector of the residual polarization of positive muons in single-crystal germanium were measured as functions of the transverse magnetic field intensity. The parameters of the muonium theory of depolarization of positive muons were calculated. (auth)

3982 VACUUM POLARIZATION IN STRONG, REALISTIC ELECTRIC FIELDS. Rinker, G.A. Jr. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544); Wilets, L. Phys. Rev. A 12: No. 3, 748-762 (Sept 1975).

Electron-positron vacuum polarization potentials, accurate to all orders n in $(Z\alpha)^n$, are calculated using realistic nuclear charge distributions for selected nuclei with $26 \leq Z \leq 114$, and for the quasimolecule U-U. We give further details of the numerical methods used in calculations previously reported, and of the improvements which have led to the present increased accuracy. The vacuum polarization potentials are employed to determine muonic energy-level shifts [order $(Z\alpha)^{n \geq 1}\alpha$] for most relevant states with $l \leq 6$. For the shifts of order $(Z\alpha)^{n \geq 1}\alpha$, interpolation procedures for all values of $Z < 137$ and for other exotic particles are noted. Although the effect of finite nuclear size is small for high-lying states [$\sim 10\%$ reduction of the $(Z\alpha)^{n \geq 1}\alpha$ terms in heavy atoms], it yields a reduction by a factor $\gtrsim 2$ for low-lying states. In the case of the quasimolecule U-U, we find that the total vacuum polarization is a minor correction to the dominant Coulomb interaction, with the first-order (Uehling) contribution remaining larger than the higher-order terms. We also present further details of a previous calculation of order $(Z\alpha)^2\alpha^2$ in muonic lead. (auth)

3983 VACUUM POLARIZATION IN A STRONG COULOMB FIELD. I. INDUCED POINT CHARGE. Brown, L.S.; Cahn, R.N.; McLerran, L.D. (Physics Department, University of Washington, Seattle, Washington 98195). Phys. Rev. D 12: No. 2, 581-595 (15 July 1975).

This is the first of a series of three papers concerned with the short-distance behavior of the vacuum polarization potential. It is this region that gives the principal energy level shift in heavy muonic atoms. In this paper we compute the induced vacuum polarization point charge that appears in the limit of a point nuclear charge source. Our result, computed analytically to all orders of $Z\alpha$, agrees with an earlier calculation of Wichmann and Kroll. We have been able to simplify the calculation considerably by taking advantage of a zero-electron-mass limit and by using formal operator and determinantal techniques. (auth)

3984 VACUUM POLARIZATION IN A STRONG COULOMB FIELD. II. SHORT-DISTANCE CORRECTIONS. Brown, L.S.; Cahn, R.N.; McLerran, L.D. (Physics Department, University of Washington, Seattle, Washington 98195). Phys. Rev. D 12: No. 2, 596-608 (15 July 1975).

We continue our study of the behavior of the vacuum polarization near the nucleus, the region of importance for heavy muonic atoms. We show that the vacuum polarization potential induced by a point nuclear charge can be expanded in certain integral and nonintegral powers of the radius r, an expansion involving r^{-1}, r, $r^{2\lambda}$, and higher terms. The coefficient of the r^{-1} term was computed in the previous paper, analytically, to all orders of $Z\alpha$. In this paper we compute the coefficients of the r and $r^{2\lambda}$ terms analytically, to all orders in $Z\alpha$. Our results agree in third order with earlier calculations, which had been done only to this order. Parts of our calculation are considerably simplified by an expansion in powers of the electron mass using formal operator and determinantal techniques. (auth)

3985 VACUUM POLARIZATION IN A STRONG COULOMB FIELD. III. NUCLEAR SIZE EFFECTS. Brown, L.S.; Cahn, R.N.; McLerran, L.D. (Physics Department, University of Washington, Seattle, Washington 98195). Phys. Rev. D 12: No. 2, 609-619 (15 July 1975).

We compute the change in the vacuum polarization near a high-Z nucleus arising from the finite extent of the nuclear charge density. A massless-electron technique is exploited to permit an analytical calculation of the effect to all orders in $Z\alpha$. Applications to muonic atoms are of particular interest as tests of quantum electrodynamics. The calculation of muonic energy level shifts is carried out to lowest order in the ratio of the nuclear radius to the radius of the muonic orbit. This approximation is appropriate to many muonic states with large orbits. Our analytical results are in excellent agreement with numerical studies by Gyulassy and give as a special case the order $\alpha(Z\alpha)^3$ calculation of Arafune. The effect on muonic x rays such as those produced in the $5g_{9/2} \rightarrow 4f_{7/2}$ transition in ^{208}Pb is about 5 eV, increasing slightly the discrepancy between theory and experiment in such systems. (auth)

3986 METHOD OF K HARMONICS AND THE GROUND-STATE ENERGY OF THE POSITRONIUM NEGATIVE ION. Chowdhury (Gupta), K.R.; Sural, D.P.; Roy, T. (Department of Physics, Jadavpur University, Calcutta-32, India). Phys. Rev. A 12: No. 3, 763-767 (Sept 1975).

The method of K harmonics, which has been successfully used to find some of the basic characteristics of a nucleus, is applied to determine the ground-state energy of the positronium negative ion, $e^-e^+e^-$. Retaining K harmonics up to $K = 2$ in the expansion for the wave function, the ground-state energy comes out as -0.256 (in a.u.). The energy value improves to -0.259 when the K harmonics up to $K = 4$ are included. (auth)

Collision Phenomena

Refer also to abstracts 2629, 2649, 3940, 3950, 3960, 3967, 3973, 4288, 4289, 4543, and 4601.

3987 (IKF-34, pp 79-80) K-SHELL IONIZATION INDUCED BY ^{32}S IONS. Tserruya, I. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Schule, R.; Schmidt-Boecking, H.; Zekl, H.; Bethge, K. 1974. (In German)

In annual report, 1974. (Frankfurt Univ. (F.R. Germany). Inst. fuer Kernphysik).

3988 (IKF-34, pp 81-82) MO X RADIATION FROM THE UNITED Z = 94 SYSTEM. Groeneveld, K. O. (Univ., Frankfurt am Main); Knaf, B.; Presser, G. 1974. (In German).

In annual report, 1974. (Frankfurt Univ. (F.R. Germany). Inst. fuer Kernphysik).

3989 (IKF-34, pp 84-85) TARGET THICKNESS DEPENDENCE OF X-RAY YIELDS FROM HEAVY-ION COLLISIONS IN SOLID TARGETS. Groeneveld, K. O.; Kolb, B.; Shader, J. (Univ., Frankfurt am Main). 1974. (In German).

In annual report, 1974. (Frankfurt Univ. (F.R. Germany). Inst. fuer Kernphysik).

3990 (IKF-34, pp 93-94) MEASUREMENTS OF DIFFERENTIAL CROSS SECTIONS FOR L-SHELL IONIZATION AS A FUNCTION OF THE IMPACT PARAMETER OF THE p-^{208}Pb SYSTEM. Stiebing, K. (Univ., Frankfurt am Main); Schmidt-Boecking, H.; Tserruya, I.; Schule, R.; Bethge, K. 1974. (In German)

In annual report, 1974. (Frankfurt Univ. (F.R. Germany). Inst. fuer Kernphysik).

3991 (IKF-34, pp 95-97) STUDY OF THE MO X RADIATION FROM THE COLLISION SYSTEM OF S ON Cl. Schmidt-Boecking, H. (Univ., Frankfurt am Main); Tserruya, I.; Schule, R.; Gaukler, G.; Bethge, K. 1974. (In German)

In annual report, 1974. (Frankfurt Univ. (F.R. Germany). Inst. fuer Kernphysik).

3992 (LBL-4000, pp 235-236) MEASUREMENT OF K X-RAY YIELD IN 100 MeV Pb + Pb COLLISIONS AND AN APPROXIMATE SCALING LAW FOR K VACANCY PRODUCTION IN HEAVY-ION COLLISIONS WITH Z > 10. Meyerhof, W. E. (Univ. of California, Berkeley); Anholt, R.; Saylor, T. K.; Bond, P. D. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

3993 (LBL-4000, pp 237-239) OBSERVATION OF MOLECULAR ORBITAL K X-RAYS IN HEAVY ION COLLISIONS. Meyerhof, W. E. (Lockheed Palo Alto Research Lab., CA); Saylor, T. K.; Lazarus, S. M.; Little, W. A.; Triplett, B. B.; Chase, L. F. Jr.; Anholt, R. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

3994 (LBL-4000, pp 240-242) DESCRIPTION OF THE ONE AND TWO COLLISION MOLECULAR ORBITAL X-RAY YIELD. Anholt, R. Jul 1975.
In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

3995 (LBL-4000, pp 243-244) SECONDARY ELECTRON BREMSSTRAHLUNG YIELD IN SYMMETRIC HEAVY ION COLLISION. Anholt, R.; Rasmussen, J. O. Jul 1975.
In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

3996 (LBL-4000, pp 245-246) X-RAY CONTINUA IN 60 MeV Br AND 202 MeV Kr BOMBARDMENTS OF Au, Pb, AND U. Anholt, R. (State Univ. of New York, Albany); Rasmussen, J. O.; Bakhru, H.; Cue, N.; Saylor, T. K.; Lazarus, S. M.; Little, A. Jul 1975.
In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

3997 PHOTON INTERACTIONS IN A CESIUM BEAM. Nygaard, K. J.; Jones, J. D. (Missouri Univ., Rolla (USA)); Hebner, R. E. Jr. (National Bureau of Standards, Washington, D. C. (USA)). pp 534-544 of Proceedings of the 4th International Symposium on the Molecular Beams. Cannes, France, 9-12 July 1973. Paris, France; Bartheye (1974).
From 4th international symposium on the molecular beams; Cannes, France (9 Jul 1973).
Photoionization of excited cesium atoms in the $6^2P_{3/2}$-state has been studied in a triple crossed-beam experiment. A thermal beam of cesium atoms was intersected by one photon beam of wavelength 8521A that served to excite the atoms and another photon beam with wavelengths below 5060A that served to ionize the excited atoms. The resulting ions were detected with a channel electron multiplier. All background effects were discriminated against by chopping the beam of exciting radiation and by analyzing the net count rate with digital synchronous techniques. The relative cross section for photoionization of $Cs(6^2P_{3/2})$ has been measured from threshold (5060A) to 2500A. The results fall off faster than the theoretical calculations of Weisheit and Norcross. (FR)

3998 ELECTRONIC EXCITATION IN COLLISIONS OF H^+ AND H WITH N_2. Birely, J. H. (Aerospace Corp., El Segundo, Calif. (USA)). pp 482-499 of Proceedings of the 4th International Symposium on the Molecular Beams. Cannes, France, 9-12 July 1973. Paris, France; Bartheye (1974).
From 4th international symposium on the molecular beams; Cannes, France (9 Jul 1973).
The 200-500 nm radiation excited by collisions of a beam of 1.5-25 keV H^+ or H with N_2 has been studied under thin-target conditions with a viewing geometry chosen to minimize polarization effects. For both H^+ and H impact, the $N_2^+(B^2\Sigma_u^+ - X^2\Sigma_g^+)$ first negative bands are the most intense spectral features in this wavelength range. As expected from consideration of electron spin conservation, the probability of excitation of the $N_2(C^3\Pi_u - B^3\Pi_g)$ second positive bands by H impact greatly exceeds that for H^+ bombardment. Relative emission cross sections for the 0-0 bands of the first negative system at 391.5 nm and the second positive system at 337.1 nm were determined and made absolute via normalization to measurements reported at higher energies by previous workers. Cross sections for formation of $N_2^+B^2\Sigma_u^+$ and $N_2C^3\Pi_u$ in the $v' = 0$ vibrational level were derived from the measured emission cross sections and known transition probabilities. A maximum in the cross section for formation of $N_2^+B^2\Sigma_u^+$, $v' = 0$ of 9.7×10^{-17} cm^2 at 10 keV was found for H^+ impact while for H, the cross section for this process rises steadily with increasing collision energy until reaching a nearly constant value of 2.9×10^{-17} cm^2 in the 15-25 keV range. The fraction of the total N_2^+ yield that is formed in the B state is about 0.05 to 0.08 in the energy range studied. For formation of $N_2C^3\Pi_u$ with $v' = 0$, the cross section has maximum value of 1.24×10^{-17} cm^2 at 5 keV. At H atom energies below 7 keV, exchange excitation of N_2 to the $C^3\Pi_u$ state is more probable than ionization to yield N_2^+ in the B state while, at higher energies, ionization to yield the B state is the more probable process. (FR)

3999 $(^3He)_2$ MOLECULES IN SOLID ^4He. Mullin, W.J.; Guyer, R.A.; Goldberg, H.A. (Department of Physics and Astronomy, University of Massachusetts, Amherst, Massachusetts 01002). Phys. Rev. Lett. 35: No. 15, 1007-1010 (13 Oct 1975).
The general features of $T_1(\omega)$ data on dilute ^3He in solid ^4He are explained in terms of coupled rotation-translation motions of $(^3He)_2$ molecules bound together by the elastic ^3He-^3He interaction. As the concentration of ^3He is lowered the molecular motions become two-dimensional and give rise to the anomalous structure observed in the $T_1(\omega)$ spectrum. (auth)

4000 L_{III}/L_{II} IONIZATION CROSS SECTION RATIOS AT LOW ENERGIES NEAR $Z=79$. Morgan, J.F.; Chang, C.N.; Blatt, S.L. (Department of Physics, The Ohio State University, Columbus, Ohio 43210). Phys. Rev. A 12: No. 4, 1731-1732 (Oct 1975).
The ratio of the L_{III} to L_{II} ionization cross sections for low-energy α particles has been remeasured, with better experimental precision, to lower energies than our previous data. Two additional elements near gold, namely tungsten and lead, have been included. While all the elements studied deviate from PWBA calculations, the anomalous behavior of the gold and platinum ratios reported earlier is still observed. (auth)

4001 ADDENDUM: LOW-ENERGY ELECTRON SCATTERING BY ATOMIC OXYGEN. Thomas, L.D.; Nesbet, R.K. (IBM Research Laboratory, San Jose, California 95193). Phys. Rev. A 12: No. 4, 1729-1730 (Oct 1975).
Our recently computed differential cross sections for elastic electron scattering from the ground state of oxygen have been used to compute momentum-transfer cross sections for energies $0.136 \leq E\,(eV) \leq 11.02$. Leading terms from the threshold laws have been used to estimate the zero-temperature limits of the rate constants for deactivation by electron impact. (auth)

4002 K-SHELL IONIZATION CROSS SECTIONS FOR 0.5-2.0-MeV PROTONS ON Kr. Lennard, W.N.; Mitchell, I.V. (Chalk River Nuclear Laboratories, Atomic Energy of Canada Limited, Chalk River, Ontario, Canada). Phys. Rev. A 12: No. 4, 1723-1724 (Oct 1975).
We report measurements of Kr K-shell ionization cross sections for 0.5-2.0-MeV protons on ion-implanted Si(Kr) targets. Our results do not agree with earlier measurements made using gaseous Kr targets but are consistent with thin, solid-target results for other medium-Z elements. (auth)

4003 EVALUATION OF THE COULOMB INTEGRAL FOR SCATTERING PROBLEMS. Mukherjee, S.C.; Roy, K.; Sil, N.C. (Indian Association for the Cultivation of Science, Jadavpur, Calcutta 32, India). Phys. Rev. A 12: No. 4, 1719-1721 (Oct 1975).
A six-dimensional integral in the coordinate space of two particles 1 and 2, where the integrand contains Coulomb functions for both the particles, the term $1/|\vec{r}_1 - \vec{r}_2|$, and an exponential term, is reduced to a double integral in real space. The resulting integral can finally be integrated numerically with a high degree of accuracy. This technique has been verified by its application to the Nordsieck integral for bremsstrahlung with different sets of parameters and compared with the exact method of Nordsieck. The error estimate is always found to be less than 0.01%. (auth)

4004 CHARGE-EXCHANGE CONTRIBUTION TO THE Kr K-VACANCY CROSS SECTIONS FOR $Cl^{15+, 16+, 17+}$-Kr COLLISIONS. Hopkins, F. (Physics Department, State University of New York at Stony Brook, Stony Brook, New York 11794); Cue, N.; Dutkiewicz, V. Phys. Rev. A 12: No. 4, 1710-1712 (Oct 1975).
The empirically scaled Brinkman-Kramers expression for charge exchange is found to account for the enhancement in target K x-ray production for fully stripped projectiles over that for two-electron projectiles even for collision partners as heavy as Cl on Kr. (auth)

4005 DIFFERENTIAL CROSS SECTION FROM AN OPERATOR VIEWPOINT. Snider, R.F. (Department of Chemistry, University of British Columbia, Vancouver, V6T 1W5, Canada). J. Chem. Phys. 63: No. 8, 3256-3262 (15 Oct 1975).
It is shown that a differential cross section can be identified as a matrix element of a transition superoperator between an observable (density operator) describing unit planar flux and an observable operator for unit spherical flux per steradian. The analysis exactly parallels the usual treatment of scattering of wavefunctions, but is done entirely in terms of density operators. The large distance (far from the scattering center) behavior of the scattered density operator is conveniently described in terms of the equivalent Wigner distribution function. For simplicity of presentation, rearrangement collisions are excluded from discussion, but the treatment may easily be extended to include such effects. (auth)

4006 ANGULAR DISTRIBUTION OF N^+ FROM DISSOCIATIVE IONIZATION OF N_2 NEAR THRESHOLD. Van Brunt, R.J.; Kieffer, L.J. (Joint Institute for Laboratory Astrophysics, University of Colorado and National Bureau of Standards, Boulder, Colorado 80302). J. Chem. Phys. 63: No. 8, 3216-3221 (15 Oct 1975).
Translational kinetic energy and angular distributions of N^+ from dissociative ionization of N_2 have been measured at electron energies close to threshold. For electron energies above 50 eV the energy distributions agree favorably with earlier measurements of Kieffer and Van Brunt. The ion energy distributions at electron energies below 50 eV are dominated by a feature peaked at a kinetic energy below 1 eV in agreement with recent measurements of Locht *et al.* For electron energies closest to threshold the angular distribution of N^+ associated with this feature is consistent with the previously proposed mechanism involving excitation of the $C^2\Sigma^+_u$ state followed by predissociation. At

higher electron energies the degree of anisotropy increases and then rapidly decreases suggesting a significant contribution from direct excitation to the $^4\Sigma^+_g$ repulsive state of N^+_2 leading to fragments in their ground states. (auth)

4007 FAST METASTABLE FRAGMENTS PRODUCED BY DISSOCIATIVE EXCITATION OF CARBONYL SULFIDE. Van Brunt, R.J. (Joint Institute for Laboratory Astrophysics, University of Colorado and National Bureau of Standards, Boulder, Colorado 80302); Mumma, M.J. J. Chem. Phys. 63: No. 8, 3210-3215 (15 Oct 1975).

Dissociative excitation of OCS by electron impact has been studied using the method of translational spectroscopy. Time-of-flight distributions and excitation functions of the fast metastable fragments have been measured. The results are compared with similar measurements on CO_2 and show that a variety of metastable fragments including $CO(a\,^3\Pi)$, $S(^3S)$, $O(^3S)$ as well as long lived high lying atomic and molecular Rydberg fragments can contribute to dissociation. (auth)

4008 THE ELASTIC AND INELASTIC SCATTERING OF DIATOMIC MOLECULES BY ATOMS: CsI+Ar, CsCl+Ar, CsI+Xe. Armstrong, W.D.; Conley, R.J.; Creaser, R.P.; Greene, E.F.; Hall, R.B. (Metcalf Chemical Laboratories, Brown University, Providence, Rhode Island 02912). J. Chem. Phys. 63: No. 8, 3349-3364 (15 Oct 1975).

Measurements of differential cross sections for the elastic and inelastic scattering of CsI by Ar, of CsI by Xe, and of CsCl by Ar are reported at three relative translational energies E in the range 4–17 kJ mol^{-1}. Both excitation and deexcitation of the molecules, which have internal energies approximately those of a gas at 844 K, occur with cross sections approaching those of elastic scattering for center-of-mass angles of 40° or greater. No rainbow structure is apparent; presumably either E is below the threshold for the transition from orbiting to rainbow scattering, or E is so high that any rainbow structure is obscured by the scattering near the primary beam, or more probably the molecular asymmetry and dipole moment cause complicated trajectories. The absence of structure corresponding to purely vibrational transitions, even when this would be resolved by the apparatus, suggests that a substantial fraction of the inelastic events involve changes in rotational energy. (auth)

4009 DISSOCIATION OF METHANE BY ELECTRON IMPACT. Winters, H.F. (IBM Research Laboratory, San Jose, California 95193). J. Chem. Phys. 63: No. 8, 3462-3466 (15 Oct 1975).

The total dissociation cross section for methane is reported for electron energies between 10 and 500 eV. A maximum cross section of 4×10^{-16} cm^2 occurs at 85 eV. Dissociation into ionic and neutral fragments have about equal probability for energies between 50 and 500 eV. At lower energies most of the fragments are uncharged, ground state, or long lived excited state molecules. The experimental technique is discussed in detail and criteria established for determining gases for which similar methods can be applied. (auth)

4010 AN L-DOMINANT SIMPLIFICATION OF THE CLOSE-COUPLED EQUATIONS FOR COLLISIONS BETWEEN ATOMS AND DIATOMIC MOLECULES. DePristo, A.E.; Alexander, M.H. (Department of Chemistry, University of Maryland, College Park, Maryland 20742). J. Chem. Phys. 63: No. 8, 3552-3559 (15 Oct 1975).

A major obstacle to the efficient quantum-mechanical treatment of collisions between atoms and diatomic molecules is the rapid proliferation in the number of coupled equations due to the $2j+1$ projection degeneracy associated with each rotational level. Recently, considerable effort has been devoted to the development of practical methods for reducing the dimensionality of these coupled equations while preserving the physically important aspects of the coupling between rotational levels. Reduction is often achieved by simplifying the role played by the centrifugal barrier. However, when collisions at large total angular momentum (large J) make a major contribution to the total cross section, the orbital angular momentum l exerts considerable importance. A model calculation on the Ar+N_2 system indicated that at large J the T matrix is dominated by transitions between states characterized by small centrifugal barriers. Consequently, we have developed an "l-dominant" (LD) approximation which consists in neglecting all chfnnels with $l>J$. Simple relations have been constructed to replace the flux corresponding to the eliminated channels. The LD method is expected to work best for inelastic processes, which are insensitive to the phase of the T matrix. Opacity functions for Ar–N_2 collisions were calculated and compared with conventional close coupling (CC) results as well as the predictions of the effective potential (EP) and coupled states (CS) simplification schemes. The LD results reproduce, both qualitatively and quantitatively, the exact values and are considerably more accurate than those corresponding to the EP and CS methods, particularly in the important large-J region. An additional comparison study indicates that the degree of accuracy of the LD method is largely insensitive to the anisotropy of the potential. Computationally, the LD method represents a significant savings over a full CC calculation. (auth)

4011 ELECTRON IMPACT EXCITATION OF THE GAMMA BANDS OF NITRIC OXIDE. Imami, M.; Borst, W.L. (Department of Physics and Astronomy, Southern Illinois University of Carbondale, Carbondale, Illinois 62901). J. Chem. Phys. 63: No. 8, 3602-3605 (15 Oct 1975).

The excitation of several pronounced γ bands of NO by electron impact was studied from threshold to 1000 eV. A high optical efficiency was achieved by using an ellipsoidal collision chamber with mirrored interior surfaces. The interaction volume viewed was located at one of the foci of the ellipsoid. A 0.25 m double monochromator and single photon counting techniques were employed to monitor molecular band intensities. The optical sensitivity between 2000 and 4000 Å was obtained with the molecular branching ratio method by monitoring $1NG$ CO^+, $1NG$ N^+_2, $2PG$ N_2 band intensities and suitable progressions in the γ system of NO. Second order effects were avoided by low NO densities ($\sim 10^{-4}$ torr) in the collision chamber. No ionization gauges were used during measurement, thus eliminating the possible dissociation of NO and subsequent formation of N_2. Absolute cross sections for γ bands were obtained by normalizing to the $2PG$ (0,0) band of N_2. For this purpose, a known mixture of NO and N_2 was prepared in a gas handling manifold using a manometer. For the unambiguously identifiable (0,1), (0,2), (1,0), (1,5), and (2,7) γ bands of NO, the cross sections peaked near 18 eV and had values of 2.2, 1.8, 6.3, 1.3, and 0.57×10^{-19} cm^2, respectively, with a possible error of 25%. The relative peak cross sections agree with calculated band intensities within 20%. (auth)

4012 LOW ENERGY DYNAMICS FOR REACTIVE COLLISIONS OF C^+ WITH D_2. Herbst, E. (Department of Chemistry, College of William and Mary, Williamsburg, Virginia 23185); Champion, R.L.; Doverspike, L.D. J. Chem. Phys. 63: No. 8, 3677-3678 (15 Oct 1975).

The reaction $C^+ + D_2 \rightarrow CD^+ + D$ has been studied with an ion-beam, gas-target scattering apparatus over the energy range 0.64–1.58 eV. The results indicate that no long-lived complex is formed in the reaction, however the product excitation and the backscattering indicate a strong three-body interaction. (AIP)

4013 L-SHELL X-RAY PRODUCTION CROSS SECTIONS FOR ^{16}O IONS ON Ce, Pr, Sm, Eu, Dy, AND Ho: 0.50 TO 2.25 MeV/amu. Pepper, G.H.; Lear, R.D.; Gray, T.J. (Department of Physics, North Texas State University, Denton, Texas 76203); Chaturvedi, R.P.; Moore, C.F. Phys. Rev. A 12: No. 4, 1237-1245 (Oct 1975).

L-shell and individual x-ray production cross sections for 8–36-MeV oxygen ions on thin solid targets of Ce, Pr, Sm, Eu, Dy, and Ho are measured and compared with predictions of theories of direct Coulomb ionization. In comparing theory and experiment, we use, with reasonable justification, fluorescence yields, Coster-Kronig yields, and radiative widths obtained from single-hole initial configurations. The theoretical treatment which provides the best overall fit to the data is the plane-wave Born approximation with corrections for Coulomb deflection of the projectile and increased binding of the target electrons. The effects of multiple ionization are examined through measurement of x-ray energy shifts as measured with Si(Li) detectors and by vacuum crystal-spectrometer measurements of L x-ray spectra produced by 3-MeV proton and 25-MeV oxygen-ion bombardment of a thick La target. (auth)

4014 SHARING OF K VACANCIES IN HEAVY-ION–ATOM COLLISIONS. Jones, K.W.; Jundt, F.C.; Guillaume, G.; Fintz, P. (Laboratoire de Physique Nucléaire et d'Instrumentation Nucléaires, Centre de Recherches Nucléaires et Université Louis Pasteur, Strasbourg, France). Phys. Rev. A 12: No. 4, 1232-1236 (Oct 1975).

The production of K vacancies has been measured for target and projectile atoms in Ne-Al and Ar-Al, -Cl, -Ti, -Cr, -Fe, -Ni collisions at energies ranging from 0.75 to 16 MeV. The results have been examined in terms of the K-vacancy-sharing theory of Meyerhof. Agreement between theory and experiment is generally good, although there is some indication of deviations at low energies. (auth)

4015 THEORETICAL INVESTIGATION OF THE NONADIABATIC INTERACTIONS AND THE TRANSLATIONAL FACTORS IN PROTON-HYDROGEN COLLISIONS. Hatton, G.J.; Chen, J.C.Y.; Ishihara, T. (Department of Physics and Institute for Pure and Applied Physical Sciences, University of California, San Diego, La Jolla, California 92037); Watson, K.M. Phys. Rev. A 12: No. 4, 1281-1296 (Oct 1975).

The interaction in the (p^+, H) collision system is examined in terms of the exact H_2^+ and H electronic states. The nonadiabatic interactions between the H_2^+ electronic states which asymptotically go to the $n=1$ or $n=2$ atomic states are calculated together with the corresponding translational contributions. The question concerning the choice of the space-fixed and rotating atomic bases is investigated in relation to the long-range interactions. The adiabatic-diabatic question is discussed in connection with the noncrossing rule and dynamic correlations between the separated and united atomic states. With the aid of the calculated interactions, the "coupling hypothesis," which

states that the nonadiabatic transitions are directly correlated with the closest approach of the electronic state energies, is examined. The characteristic features of the radial and rotational couplings are discussed in a phase-interference model. (auth)

4016 DESTRUCTION OF 0.1–3000-eV METASTABLE HYDROGEN ATOMS IN COLLISIONS WITH HELIUM AND ARGON. Dose, V.; Hett, W. (Physikalisches Institut der Universität Würzburg, 8700 Würzburg, Röntgenring 8, Germany); Olson, R.E.; Pradel, P.; Roussel, F.; Schlachter, A.S.; Spiess, G. Phys. Rev. A 12: No. 4, 1261-1270 (Oct 1975).

Total deactivation cross sections for collisions of metastable H ($2\,^2S$) on He and Ar have been measured in the energy range 0.1–3000 eV. At low collision energies an apparatus designed to utilize time-of-flight techniques was used, while at the high energies an apparatus that employed beam-attenuation techniques was used. The cross sections are found to be on the order of 10^{-14} cm^2 at the lowest energies and decrease slowly to approximately 10^{-15} cm^2 at the highest energies. The experimental data were analyzed to obtain information about the difference in potential energies, $\Delta V(R)$, between the two $^2\Sigma$ molecular states arising from the H(n=2)+He and Ar separated atoms. Our analysis also shows that the dominant deactivation mechanism of H($2\,^2S$) at energies less than 500 eV is excitation to H($2\,^2P$), which rapidly radiates to the ground state. (auth)

4017 INELASTIC PROCESSES IN ION-MOLECULE COLLISIONS: Ar^+ AND HE^+ ON N_2 AT LOW-keV ENERGIES. Fernandez, S.M.; Eriksen, F.J.; Bray, A.V.; Pollack, E. (Department of Physics, University of Connecticut, Storrs, Connecticut 06268). Phys. Rev. A 12: No. 4, 1252-1260 (Oct 1975).

The $Ar^+ + N_2$ collision is studied at energies from 1.0 to 3.0 keV and in an angular range between 0 and 4.0 deg. The energy-loss spectra of the scattered ions demonstrate the presence of elastic scattering and inelastic processes arising from vibro-rotational excitation of the ground electronic state of N_2, electronic excitation of the target with concomitant vibro-rotational excitation, and target ionization. Studies of the angular dependence of these processes suggest that (a) the collisions involve the entire molecule and are thus not adequately described in terms of a binary collision model, (b) electronic and vibrational excitation occur via mechanisms which exhibit negligible coupling, and (c) electronic excitation of N_2 is due predominatly to the $B\,^3\Pi_g \rightarrow X\,^1\Sigma_g^+$ transition as evidenced by observation of the onset of dissociation at larger scattering angles. The probability of charge exchange in $Ar^+ + N_2$ and $N^+ + N_2$ collisions is also investigated and shows an angular behavior very similar to that found in $He^+ + N_2$. Inelastic scattering results for $He^+ + N_2$ are reported. (auth)

4018 PURE ROTATIONAL EXCITATION OF H_2 AT ELECTRON IMPACT ENERGIES OF 3 TO 100 eV. Srivastava, S.K.; Hall, R.I.; Trajmar, S.; Chutjian, A. (Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, California 91103). Phys. Rev. A 12: No. 4, 1399-1401 (Oct 1975).

Cross sections for pure rotational excitation (J=1→3) in H_2 are reported at electron energies E_0 of 15 eV to 100 eV at scattering angles θ of 115°, 3 to 40 eV at 20°, and at 40 eV at angles between 10° and 135°. It is found that for intermediate E_0 the probability of pure rotational excitation at high θ is greater than that for elastic scattering. Moreover, this probability is found to decrease slowly with E_0, having a value at its peak (at 4 eV) which is only ~20 times that at 100 eV. (auth)

4019 K-SHELL AUGER-ELECTRON HYPERSATELLITES OF Ne. Woods, C.W.; Kauffman, R.L.; Jamison, K.A.; Stolterfoht, N.; Richard, P. (Department of Physics, Kansas State University, Manhattan, Kansas 66506). Phys. Rev. A 12: No. 4, 1393-1398 (Oct 1975).

The cross section for production of excited Ne ions with double K-shell vacancies is measured by observing the Auger electrons from the decay of these states. A Ne-gas target is bombarded by 1–2-MeV/amu N, O, and F projectiles in various incident charge states. The K-shell Auger hypersatellites are observed only for bare nuclear projectiles. The projectile charge-state dependence, projectile Z dependence, and energy dependence of the cross section suggest K-shell electron exchange as a production mechanism. (auth)

4020 DIFFERENTIAL CROSS SECTIONS FOR ELASTIC ELECTRON SCATTERING. CHARGE-CLOUD POLARIZATION IN H_2. Fink, M. (Physics Department and Electronics Research Center, University of Texas, Austin, Texas 78712); Jost, K.; Herrmann, D. Phys. Rev. A 12: No. 4, 1374-1382 (Oct 1975).

Relative elastic differential cross sections for electrons scattered from H_2 have been measured for angles between 3 and 130 deg and electron energies between 100 and 1000 eV. The data agree very well with the first Born theory by Ford and Browne, and Liu and Smith for angles larger than 30 deg; however, strong deviations are found in the small-angle range. This discrepancy is discussed from the point of view of charge-cloud polarization and its adiabatic limit. It was found that the cross sections have not yet reached the adiabatic limit at 100 eV. The differential cross sections are integrated, and the total elastic cross sections are determined. The present values continue smoothly to the results of Truhlar *et al.* and are compatible with those of Ulsh, Wellenstein, and Bonham. (auth)

4021 MOLECULAR-ORBITAL-K-VACANCY PRODUCTION BY DIRECT IMPACT IN SYMMETRIC HEAVY-ION COLLISIONS. Thorson, W.R. (Department of Chemistry, University of Alberta, Edmonton, Alberta, Canada). Phys. Rev. A 12: No. 4, 1365-1373 (Oct 1975).

Using simple scaling laws based on the adiabatic approximation, Meyerhof and co-workers have compared experimental data on K-vacancy production cross sections for symmetric collisions of heavy atoms and ions, with *ab initio* calculations of cross sections for direct impact ionization of hydrogen atoms by slow protons, done in this laboratory. It is shown here that the relative magnitudes and energy dependences of such cross sections can be understood using a simplified model theory; dominant features are determined by the oscillatory exponential factors associated with momentum and energy loss by the heavy particles, rather than the electronic-coupling matrix elements. (auth)

4022 CROSS SECTIONS FOR L X—RAY PRODUCTION AND L-SUBSHELL IONIZATION BY MeV ELECTRONS. Park, Y.K.; Smith M.T.; Scholz, W. (Department of Physics, State University of New York at Albany, Albany, New York 12222). Phys. Rev. A 12: No. 4, 1358-1364 (Oct 1975).

A systematic study of L x-ray production and L-subshell ionization by MeV electron impact has been made. Cross sections were measured for 14 elements from Ba (Z = 56) to Bi (Z = 83) at electron bombarding energies of 1.04, 1.39, and 1.76 MeV. Within the error limits there is no dependence on the electron energy. At all energies, measured L x-ray production cross sections exhibit a gradual increase with atomic number. For the heavier elements, typical average values for the $L\alpha$, $L\beta$, and $L\gamma$ group are 70, 55, and 9 b, respectively. L-subshell ionization cross sections were derived from the $L\alpha$, $L\beta$, and $L\gamma$ x-ray production cross sections with the use of theoretical L-subshell fluorescence yields, Coster-Kronig yields, and radiative branching ratios. The total L-shell ionization cross section drops from 1200 b at Ba (Z = 56) to 380 b at Bi (Z = 83) with individual L-subshells contributing roughly in proportion to their electron number. The measured cross sections are in good agreement with the predictions of the binary-encounter collision model of Gryziński. (auth)

4023 DISSOCIATION OF THE HYDROGEN MOLECULE BY ELECTRON IMPACT. Chung, S.; Lin, C.C. (Department of Physics, University of Wisconsin, Madison, Wisconsin 53706); Lee, E.T.P. Phys. Rev. A 12: No. 4, 1340-1349 (Oct 1975).

The electron-impact dissociation cross sections of the H_2 molecule have been calculated for the processes leading to H($1s$)+H($1s$) and to H($1s$)+H($2s$) by means of the Born-Rudge and Born-Ochkur methods. In addition to direct excitation to the repulsive $b\,^3\Sigma_u^+$ state for the first process, cross sections are also computed for excitation of the discrete levels of the $a\,^3\Sigma_g^+$, $c\,^3\Pi_u$, $d\,^3\Pi_u$, and $e\,^3\Sigma_u^+$ states in order to account for cascades. These two mechanisms are found to be of equal importance. The second process is found to proceed mainly through excitation of the $B\,^1\Sigma_u^+$ state except near the threshold where $e\,^3\Sigma_u^+$ is an important contributor. The theoretical cross sections are in reasonably good agreement with experimental data for the first process. The cross sections of the second process account for nearly two-thirds of the measured cross sections of H($2s$) -atom production by electron impact. The difference is attributed mainly to predissociation and dissociative excitation through the doubly excited states. (auth)

4024 AUGER-ELECTRON AND X—RAY PRODUCTION IN 50- TO 2000-keV Ne+Ne COLLISIONS. Stolterfoht, N.; Schneider, D.; Burch, D. (Hahn-Meitner-Institut für Kernforschung Berlin GmbH, 1 Berlin 39, West Germany); Aagaard, B.; Bøving, E.; Fastrup, B. Phys. Rev. A 12: No. 4, 1313-1329 (Oct 1975).

The production of vacancies in the inner and outer shells of the target and projectile have been studied in Ne^{i+}+Ne collisions in the incident energy range of 45 keV to 2.2 MeV through the observation of K x rays and Auger electrons. Data are given for incident charge states i=0, 1, and 2. Parameters necessary for the analysis of collision kinematics were extracted from previous data and used to investigate these effects on the observed Auger spectra. The kinematic line broadening in the Ne collisions is shown to obscure the peak structure characteristic of the multiple ionization states. The centroid energies and average energy widths of the Auger groups, together with absolute intensities, are reported as a function of the Ne^{i+} energy and electron emission angle for both target and projectile. After kinematic corrections, it is found that target and projectile Auger-electron emission are isotropic to within ±10% and that the K vacancy created is equally shared between the target and projectile. The average number $\bar{n}_A$ of electrons removed from the L shell simultaneous with the K vacancy production is estimated from the centroid Auger-electron energies and compared with previously measured data. It is found that

$\bar{n}_A$ increases with the Ne^+ energy from ~2.5–3.6 over the energy range studied. Absolute cross sections for x-ray and Auger-electron production are reported with an accuracy of about ±15%, and mean fluorescence yields are determined from these cross-section data. The fluorescence yield increases with incident Ne^+-ion energy, and is consistent with the observed degree of *L*-shell ionization. Total *K*-vacancy production cross sections agree well with available calculations below 200 keV, but the theoretical results underestimate the cross sections at higher energies. This reflects a breakdown of the two-state approximation made in the calculation. Information regarding the coupling of outer-shell molecular orbitals in the entrance channel is extracted from the comparison of the measured data and previous calculations. (auth)

4025 SCATTERING OF HIGH-VELOCITY NEUTRAL PARTICLES. XVIII. HE– (CH_3F, CH_2F_2, CHF_3). Amdur, I.; Longmire, M.S.; Jordan, J.E. (Department of Chemistry, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139); Mason, E.A. J. Chem. Phys. 63: No. 7, 2926-2928 (1 Oct 1975).

Fast He beams have been scattered by room-temperature CH_3F, CH_2F_2, and CHF_3 to obtain the following average potentials (energy in eV and separation in Å): He–CH_3F, $V(r) = 3.86\times10^2/r^{8.34}$, $2.00 < r < 2.47$; He–CH_2F_2, $V(r) = 3.88\times10^4/r^{13.33}$, $2.22 < r < 2.58$; He–CHF_3, $V(r) = 4.06\times10^5/r^{15.43}$, $2.33 < r < 2.63$. Where they overlap, these results agree with independent measurements by Fink, King, and Freeman. The peripheral-force approximation, which assumes that the centers of force in a molecule are located at the nuclei of each atom, has been used to calculate potentials for the above systems from previous measurements on He–CH_4 and He–CF_4. The calculated potentials are in only fair agreement, being systematically high. Sources of the discrepancies are discussed. (auth)

4026 QUENCHING OF VIBRATIONALLY EXCITED NITRIC OXIDE BY MOLECULAR OXYGEN AND NITROGEN. Murphy, R.E.; Lee, E.T.P.; Hart, A.M. (Air Force Cambridge Research Laboratories, Hanscom AFB, Massachusetts 01731). J. Chem. Phys. 63: No. 7, 2919-2925 (1 Oct 1975).

Vibrationally excited $NO^\ddagger(X\,^2\Pi, v>0)$ was produced by energetic electrons impacting on nitrogen–oxygen gas mixtures. The time decay of the $NO^\ddagger$ fundamental vibration–rotation bands in the presence of varying concentrations of N_2 and O_2 was measured. The quenching rate constants of NO(v=1) by N_2 and O_2 were determined to be $k_{O_2} = 2.4 \pm 1.5 \times 10^{-14}$ and $k_{N_2} = 1.7 \pm 0.7 \times 10^{-16}$ cm^3 sec^{-1}, respectively. Two quenching models are considered, independent and proportional to the vibrational level of the excited $NO^\ddagger(v)$. If quenching of $NO^\ddagger$ by O_2 is independent of v, the quoted rate constant k_{O_2} becomes 75% larger. Computer intensity calculations of $NO^\ddagger(\Delta v=1)$ are compared to radiometric intensity measurements. Intensity calculations using the uncertainty limits of the experimentally measured k_{O_2} support the reliability of determined rate constants. (auth)

4027 VIBRATIONAL ENERGY TRANSFER IN POLYATOMIC MOLECULE COLLISIONS. I. HIGH ORDER CORRECTIONS TO THE TRANSITION PROBABILITIES OF VIBRATIONAL ENERGY TRANSFER. Jolicard, G.; Galatry, L. (Laboratoire de Physique Moléculaire, Université de Besançon, 25030-Besancon Cedex, France). J. Chem. Phys. 63: No. 7, 2787-2797 (1 Oct 1975).

An expansion technique of the evolution operator using the MAGNUS formalism enabled us to study the transition probability at one, two, three, and four quanta of vibration between the oscillators of two polyatomic molecules during a collision. In this paper the collisions are supposed to be not energetic enough to cause a series of multiple transitions, and the theory allowed us to study the validity of the first approximation of Born. At the same time the present work proposes a preliminary approach to the influence of the cubic and quartic potential constants and of the vibrational resonance on the vibrational transitions induced by collisions between polyatomic molecules. The theory is then applied to the collision CO_2–He. (auth)

4028 VIBRATIONAL ENERGY TRANSFER IN POLYATOMIC MOLECULE COLLISIONS. II. ROLE OF MULTIQUANTUM TRANSITIONS DURING VERY ENERGETIC COLLISIONS. Jolicard, G. (Laboratoire de Physique Moléculaire, Université de Besançon, 25030-Besancon Cedex, France). J. Chem. Phys. 63: No. 7, 2798-2804 (1 Oct 1975).

In a previous paper the processes of vibration energy transfer during a collision between two polyatomic molecules were studied using an operational calculation approach. This has enabled us to present analytical expressions for the probabilities of various events occuring during the collision of two diatomic molecules. A comparison with previous numerical calculations confirms the presence and the influence during these transfers of mechanisms which alter the characteristics of the nonperturbed oscillators and of multiquantum transitions. (auth)

4029 RESOLUTION CORRECTIONS IN TOTAL SCATTERING CROSS SECTION MEASUREMENTS. Gislason, E.A. (Department of Chemistry, University of Illinois at Chicago Circle, Chicago, Illinois 60680). J. Chem. Phys. 63: No. 7, 2828-2834 (1 Oct 1975).

An expression is derived for the resolution correction based on the measured incident beam profile in the detector plane. The results are valid for any experimental configuration. Comparison is made with earlier treatments of this correction. The result given here will permit more accurate analysis of total scattering cross section measurements. Sample calculations are described and applied to recent determinations of the He–He potential. Finally, an expression is obtained for the small-angle elastic differential cross section which can be used to deconvolute experimental measurements. (auth)

4030 TESLA TRANSFORMER ACCELERATOR FOR THE PRODUCTION OF INTENSE RELATIVISTIC ELECTRON BEAMS. Boscolo, I.; Brautti, G.; Coisson, R.; Leo, M.; Luches, A. (Istituto di Fisica, Università di Lecce, Lecce 73100, Italy). Rev. Sci. Instrum. 46: No. 11, 1535-1538 (Nov 1975).

A resonant transformer high-voltage (HV) generator is described that delivers a 1.1-MV peak on the HV head of the secondary circuit. The HV head feeds a field emission diode that gives out a 6-kA/20-nsec electron beam. High repetition rates, up to 3 pulses/sec (power supply limited), have been attained with foilless diodes. Design details and electron beam characteristics are given and discussed. (auth)

4031 HYDROGEN–ATOM SCATTERING: ENERGY DEPENDENCE OF THE TOTAL COLLISION CROSS SECTION FOR MERCURY. Stwalley, W.C. (Department of Chemistry, Harvard University, Cambridge, Massachusetts 02138); Niehaus, A.; Herschbach, D.R. J. Chem. Phys. 63: No. 7, 3081-3084 (1 Oct 1975).

Total collision cross sections for scattering of H and D atoms from Hg in the energy range 10^{-5}–10^{-1} a.u. (3×10^{-4}–3 eV) are calculated for an accurate Rydberg–Klein–Rees (RKR) potential based on isotopically-combined spectroscopic data for HgH, HgD, and HgT. Comparison is made with two sets of experiments, a subthermal energy (5×10^{-3}–0.2 eV) study by the Genoa group, and a superthermal energy (0.14–1.7 eV) study at Harvard. The glory oscillations found in both studies and the orbiting resonances found in the subthermal experiments are in good agreement with the calculated cross sections. (auth)

4032 THE ROLE OF COMPLEX TRAJECTORIES IN ELASTIC SCATTERING. Gordon, R.J. (Department of Chemistry, University of Illinois at Chicago Circle, Chicago, Illinois 60680). J. Chem. Phys. 63: No. 7, 3109-3114 (1 Oct 1975).

Undulations in differential elastic cross sections have previously been attributed to interference between the amplitudes of classical trajectories having the same observed scattering angle. From this point of view, oscillations resulting from a monotonically repulsive central potential are hard to understand, since in this case there is no interference from real trajectories. We have examined in detail the complex trajectories for the potential energy function $4r^{-12}$, and found that there are complex impact parameters with real positive and negative scattering angles. We showed that the semiclassical formulation of Ford and Wheeler is accurate, provided that the first complex stationary phase point for negative scattering angles is included. (auth)

4033 QUANTUM VIBRATIONAL TRANSITION PROBABILITIES FROM REAL CLASSICAL TRAJECTORIES: COLLINEAR ATOM–DIATOM COLLISIONS. Gentry, W.R. (Chemical Dynamics Laboratory, Department of Chemistry, University of Minnesota, Minneapolis, Minnesota 55455); Giese, C.F. J. Chem. Phys. 63: No. 7, 3144-3155 (1 Oct 1975).

Quantum vibrational transition probabilities may be estimated from single, real classical trajectories by exploiting the approximate correspondence between the classical and quantal motions. In this paper we explore the range of validity of several such correspondence methods for collinear atom–diatom collisions by comparing the results with those from rigorous quantum mechanical calculations. The model systems considered here include: (a) a harmonic oscillator with (1) a repulsive exponential, (2) a Landau–Teller, and (3) a Lennard-Jones interaction potential, and (b) a Morse oscillator with a repulsive exponential interaction potential. The range of the dimensionless mass parameter M is 0.00628 to 3.737 and the total system energy ranges from 1.55 to 10.0 in units of $\hbar\omega_e$. For both Morse and harmonic oscillator excitation the semiclassical results are generally more accurate for small M and for small initial and final vibrational quantum numbers. Quantitatively, the results are consistently better for a harmonic oscillator than for a Morse oscillator. The threshold behavior for harmonic oscillator excitation can be predicted quantitatively using a classical trajectory in which the arithmetic mean of the initial and final speeds is equal to the arithmetic mean of the translational speeds for the corresponding quantum transition. By detailed balancing, the probabilities for vibrational de-excitation in slow collisions are also predicted accurately. (auth)

4034 COLLIDING BEAM MEASUREMENTS OF ICR COLLISION PROCESSES BETWEEN ALKALI ION–ATOM PAIRS. Riggin, M.; Bloom, M. (Department of Physics, University of British Columbia, Vancouver, British Columbia, Canada). J. Chem. Phys. 63: No. 7, 3046-3053 (1 Oct 1975).

A colliding beam ion cyclotron resonance experiment has been developed and used to study rate constants for symmetric (resonant) and

asymmetric charge exchange between potassium ion–atom pairs and between sodium ions and potassium atoms in the range of ionic energies from 0.1–2.0 eV. The results for symmetric charge exchange are in agreement with theory, but the rate constant for the exothermic process $Na^+ + K \rightarrow Na + K^+$ at near thermal energies appears to be much larger than predicted. The changes in the ion cyclotron double resonance (ICDR) signals of ions A^+, when ions B^+ were heated using ICR methods, were found to be sensitive in magnitude and sign to the difference between the static field strength and the A^+ ICR resonant field, as well as the intensity of the rf electric field used to heat the B^+ ions. These results have been interpreted in terms of a previously published theory which takes into account explicitly the spatial distribution of ions in the ICR cell. Semiquantitative information is obtained on the energy dependence of asymmetric charge transfer between Na^+ and K and resonant charge transfer between $^{39}K^+$ and ^{41}K at very low energies. (auth)

4035 DURATION OF HYDROGEN-ATOM SPIN-EXCHANGE COLLISIONS. Crampton, S.B.; Wang, H.T.M. (Department of Physics, Williams College, Williamstown, Massachusetts 01267). Phys. Rev. A 12: No. 4, 1305-1312 (Oct 1975).

Interruption of the hyperfine interaction during electron spin-exchange collisions shifts the hydrogen-atom ground-state $\Delta m_F = 0$ hyperfine transition frequency in proportion to the spin-exchange collision rate and to the average time T_D during which the exchange interaction interrupts the hyperfine interaction. Measurements of the thermal average T_D for hydrogen-hydrogen collisions at 308 °K in an atomic hydrogen maser confirm the predictions of a semiclassical theory and a numerical estimate using straight-line collision trajectories. Measurements of much longer T_D for hydrogen-atom collisions with O_2, NO, and NO_2 molecules are consistent with the formation of long-lived intermediate complexes during some collisions. (auth)

4036 CROSS SECTIONS FOR EXCITATION OF THE $n\,^1D$ STATES OF HELIUM BY ELECTRON IMPACT AND POLARIZATION OF THE RESULTING RADIATION IN GLAUBER THEORY. Chan, F.T.; Chang, C.H. (Physics Department, University of Arkansas, Fayetteville, Arkansas 72701). Phys. Rev. A 12: No. 4, 1383-1392 (Oct 1975).

Recently developed analytic methods, which reduce the Glauber amplitude for charged-particle–neutral-atom collisions to a one-dimensional integral representation involving modified Lommel functions, are used to evaluate the cross sections for the direct excitation of $3\,^1D$ and $4\,^1D$ states of helium by electron impact with incident energies from 40 to 1000 eV. It is shown that the Glauber amplitudes can be written in terms of three generating functions: One of these has already been derived by Thomas and Chan; the detailed reduction of the other two is given in this paper. Comparison is made with the Born, Ochkur, and Woollings-McDowell approximations. The polarization fraction of the 6678-Å helium line emitted in $e^- + He$ collisions is also calculated in the Glauber approximation. The agreement between theory and experiment is less than satisfactory in the entire energy region. (auth)

4037 DOUBLET LINE-STRENGTH RATIOS FOR THE PRINCIPAL SERIES OF CESIUM. Popescu, D. (Institute of Physics, Bucharest, Romania); Popescu, I.; Maurer, J.; Collins, C.B.; Johnson, B.W. Phys. Rev. A 12: No. 4, 1425-1431 (Oct 1975).

Space-charge amplification of the indirect ionization resulting from photoabsorption in cesium vapor has been shown to offer to conventional techniques of absorption spectroscopy a useful complement of highest sensitivity. It was used in this work together with a xenon continuum source filtered to a linewidth of 0.14 Å to measure the relative absorption probabilities for transitions of the cesium-principal-series ($6\,^2S$-$n\,^2P_{1/2,3/2}$) doublets. Anomalous pressure effects on the resulting line-strength ratios, resulting in part from polarization molecules of Cs_2*, were examined over a range of cesium-atom concentration varying from 1.2×10^{14} to 1.5×10^{15} cm^{-3}. From the corrected doublet line-strength ratios for $11 \leqslant n \leqslant 16$, the segment of the curve of Fano X parameters corresponding to discrete energies was constructed. Interpolation between these results and those from electron-polarization experiments served to locate the pole in the principal-series, doublet line-strength ratio near $19\,^2P$. (auth)

4038 PHOTOIONIZATION OF THE $6\,^2P_{3/2,1/2}$ FINE-STRUCTURE LEVELS IN CESIUM. Nygaard, K.J. (Department of Physics, University of Missouri–Rolla, Rolla, Missouri 65401); Hebner, R.E. Jr.; Jones, J.D.; Corbin, R.J. Phys. Rev. A 12: No. 4, 1440-1447 (Oct 1975).

The relative photoionization cross sections for cesium atoms selectively excited to the $6\,^2P_{3/2,1/2}$ states have been measured in a triple-crossed-beam experiment. A cesium discharge lamp produced resonant wavelengths of 8521 and 8944 Å for the excitation process. A Hg-Xe lamp combined with a grating monochromator was used for the actual ionization in the wavelength region from 2500 to 5000 Å. Background counts due to photoionization of ground-state cesium atoms and dimers as well as various surface effects were discriminated against by chopping the excitation light source. The data are compared with results from radiative-recombination measurements in which the fine-structure levels are not resolved and with recent model-potential calculations. The wavelength (λ) dependence of the cross section indicates a λ^3 dependence at threshold ($\simeq$ 5000 Å) and a λ^4 behavior at lower wavelengths. (auth)

4039 ABSOLUTE CROSS SECTION FOR EXCITATION OF A Ca^+ ION RESONANCE LEVEL BY ELECTRON IMPACT. Kelman, V.A.; Imre, A.I. Opt. Spectrosc. (USSR) 38: No. 6, 709-710 (June 1975).

Using intersecting beams of electrons and Ca^+ ions, a determination was made of the effective excitation cross section of the resonance $4\,^2P$ level in Ca II.(AIP)

4040 EXCITATION MECHANISM IN THE $Na^+ + Ne$ SYSTEM. Nikitin, E.E.; Ovchinnikova, M.Y.; Shushin, A.I. (Institute of Chemical Physics, USSR Academy of Sciences). JETP Lett. 21: No. 11, 299-300 (5 June 1975).

We calculate the polarizations and intensities of the components of the spectral lines Na($3p$) and Ne($2p^5 3p$), and discuss the possible mechanism of their excitation in $Na^+ + Ne$ collisions at high energies. The effect of maximum polarization of the $J=1 \rightarrow J=0$ lines is explained. (auth)

4041 POSSIBILITY OF EXPERIMENTAL DETERMINATION OF THE FREQUENCIES OF AUTOIONIZATION DECAY OF EXCITED MOLECULAR STATES. Kalinin, A.P.; Leonas, V.B. (Institute of Space Research, USSR Academy of Sciences). JETP Lett. 21: No. 12, 339-340 (20 June 1975).

Using as an example the study of collisions between closely approaching atoms of metastable He* (2^3S) and Ar(^1S), we demonstrate the possibility of determining the interaction potential and the width of the autoionization level of a system, from experimental data on the differential scattering. (auth)

4042 RELATIVE MEASUREMENTS OF THE BALMER ALPHA 3S, 3P, AND 3D EXCITATION CROSS SECTIONS PRODUCED BY ELECTRON IMPACT ON ATOMIC HYDROGEN. Mahan, A. H. Boulder, CO; Univ. of Colorado (1974). 243p. University Microfilms Order No. 75-13,446.

Thesis (Ph. D.).

The first measurement of the relative cross sections for excitation of the 3S, 3P, and 3D states of atomic hydrogen, produced by electron impact is presented. The incident electron impact energy ranged from near threshold (12.2ev) up to 500 eV), when the results for the optically allowed 3P cross section are normalized to the Born prediction, the 3S and 3D cross sections as derived from the measured values also fall within the Born values at this energy. As the impact energy is lowered, the 3S and 3P excitation cross sections fall below the Born predictions, as do the 2S and 2P excitation cross sections. However, the 3D excitation cross section rises above the Born prediction by about a factor of two for impact energies below 50 eV. An argument is presented that the validity of the Born prediction for a DELTA 1 equals 2 transition is questionable. The cross sections are compared with other existing theories as well as the Born predictions. No satisfactory agreement is found for the 3D case. The total H/sub alpha/ cross section is presented over the same energy range and normalized as above. A comparison is again made with the existing theories and the experiment of Kleinpoppen (1968). The present results rise considerably above those of Kleinpoppen at energies below 50 eV, and fall between the Glauber and Born predictions at lower impact energies. Since Stark mixing of the n equals 3 sublevels could mix these populations before radiation, and thus produce erroneous cross section determinations. A known electric field was therefore placed in the interaction region and the H/sub alpha/ signal profile studied. An unexpected asymmetry of this H/sub alpha/ signal profile was observed upon reversal of the electric field, and this was interpreted as a coherent excitation of pairs of Stark mixed (nLJm/sub J/) and (nL + 1Jm/sub J) substates, an effect never before observed in crossed beam measurements. (Diss. Abstr. Int., B)

4043 COMPARISON OF ARGON--ARGON INTERATOMIC POTENTIALS FROM ELASTIC MOLECULAR BEAM SCATTERING DATA. Law, M. L. Philadelphia; Univ. of Pennsylvania (1974). 138p. University Microfilms Order No. 75-14,585.

Thesis (Ph. D.).

Pair potential forms for argon--argon were analyzed using molecular beam techniques. Extrema or "glory" undulations in the velocity dependence of the total cross sections for argon--argon scattering were observed from elastic molecular beam scattering. These undulations or spacings are related to the potential shape by the equation Er/sub m/ equals hGI where E is the depth of the attractive potential well, r/sub m/ is the internuclear distance at the minimum, I is the experimental "glory" observable defined by Bernstein and Muckerman and G is a

potential-shape-dependent constant. The absolute total cross sections in molecular beam scattering were observed. The calculated total cross sections for argon--argon at different velocities v are compared with the experimental values in a $Qv^{0.4}$ vs. v curve. The "rainbow" effect in the differential elastic cross sections is used to determine the well depth E. The experimental results are compared with those obtained by others. (GHT)

4044 INTERACTIONS OF HIGHLY EXCITED HYDROGEN ATOMS: IN IONIZATION IN INTENSE ELECTROMAGNETIC FIELDS. In Electron Loss in Low Energy Merged-Beams Collisions with Protons. Koch, P. M. New Haven; Yale Univ. (1974). 394p. University Microfilms Order No. 75-15,317.

Thesis (Ph. D.).

Two different types of interactions of highly excited hydrogen atoms, H(high n), having principal quantum numbers n in the range 40 less than n less than 80 have been experimentally studied: (1) multiphoton ionization of H(high n) in intense electromagnetic fields, and (2) eV energy H^+ + H(high n) electron loss collisions. The H(high n) were made by electron transfer reactions of protons near 11 keV energy in a gas scattering cell. The absolute intensities of the H(high n) flux produced in various n-bands by H^+ + Xe collisions near 11 keV were measured in calibration experiments. Data are presented for the ionization of H(high n) in the nominal n-band 63 less than or equal to n less than or equal to 69 for electromagnetic field frequencies of about 30 MHz, 1.5 GHz, and 9.9 GHz. The data are interpreted in terms of a semi-classical theory which connects the adiabatic ionization model of barrier penetration for "low" frequency fields with the multiphoton ionization model for "high" frequency fields. The present data qualitatively confirm the predictions of this theory that higher frequency waves are more effective for ionization than are low frequency waves. The H^+ + H(high n) electron loss cross section was measured for the nominal n-band 44 less than or equal to n less than or equal to 50 over the center-of-mass collision energy range 0.4 eV less than or equal to W less than or equal to 61 eV. The measured cross section sigma/sub loss/ varies from about 8×10^{-9} cm^2 at W equals 0.4 eV to about 1×10^{-9} cm^2 at W equals 61 eV. The results of classical Monte Carlo calculations are compared to the data. Experimental data and Born approximation calculations for the H^+ + H(n equals 1) ionization cross section are classically scaled to n equals 47 for comparison with the data. These are used to unfold from sigma/sub loss/ the electron transfer cross section $sigma_{10}$. The slope B of the unfolded data, when plotted as $sigma_{10}$/sup 1/2/ equals A -BlogW, is found to be consistent with the classical scaling rules which are shown to predict that B scales as n^2. (Diss. Abstr. Int., B)

4045 LASER-INDUCED MULTIPHOTON TRANSITION RATES. Mirkovitch, M. Ann Arbor, MI; Univ. of Michigan (1974). 77p. University Microfilms Order No. 75-10,235.

Thesis. (Ph. D.).

The uses of the quantum mechanical momentum translation operator are examined in the context of the calculation of transition rates for multiphoton absorption. We consider the transition operator for radiative processes induced in non-relativistic, spinless, hydrogen-like atoms in the dipole approximation, with the interaction Hamiltonian given by terms linear and quadratic in the vector potential. It is shown that the transition rate is generally expressible in terms of the transition operator corresponding to the Hamiltonian which is the transform under momentum translation of the original Hamiltonian, so that the interaction is effectively the electric field-electric dipole operator. A modified form of the original transition operator is derived, which yields the quantum mechanical analog of the recently proposed semi-classical momentum translation approximation. We examine the successive approximation scheme suggested by this procedure and use the large photon number limit of the representation of the momentum translation operator in the occupation number basis to derive the semiclassical result for the lowest order multiphoton transition matrix. Higher order corrections are considered and a comparison is carried out with the transition matrix which results from using the electric field interaction operator. Projection operator algebra is used to derive a particularly convenient expression for the transition matrix for resonant multiphoton absorption. This comparison displays the details of a cancellation effect which casts doubt on the usefulness of the modified transition operator as a substitute for conventional iterative techniques in the calculation of multiphoton transition rates. (Diss. Abstr. Int., B)

4046 THRESHOLD BEHAVIOR OF COLLISIONAL IONIZATION PROCESSES. Leffert, C. B. Detroit; Wayne State Univ. (1974). 365p. University Microfilms Order No. 74-29,827.

Thesis (Ph. D.).

Crossed molecular-beam studies have been conducted for collisional-ionization (CI) reactions: Cs + XY yields Cs^+ + XY^-, (CI) and collision-induced dissociation (CID) reactions: Cs + XY yields Cs^+ + X + Y^-, (CID) where X and Y may be atoms or molecules. The cross section for the production of Cs^+ was measured. The center-of-mass (c.m.) threshold energies (E_0) for these endoergic reactors, assuming ground-state reactants and products, are E_0(CI) equals I(Cs) - A(XY$^-$) and E_0(CID) equals I(Cs) + D_0(XY) - A(Y$^-$) equals I(Cs) + D_0(XY$^-$) - A(XY$^-$), where A, D_0, and I are the electron affinity, bond-dissociation energy, and ionization potential, respectively. Appropriate A and D_0 values for the target molecules were deduced from these relations with the measured E_0 and known I(Cs). (Diss. Abstr. Int., B)

4047 MERGING NOZZLE BEAM APPARATUS FOR MEASUREMENT OF MOLECULAR CROSS SECTIONS: HELIUM--ARGON AND HELIUM--NEON CROSS SECTIONS AT SUBTHERMAL ENERGIES. Pope, W. M. Tallahassee; Florida State Univ. (1974). 107p. University Microfilms Order No. 75-12,666.

Thesis (Ph. D.).

A molecular scattering apparatus containing nozzle beams that intersect at 22^0 was constructed. The nozzle sources of each beam could be operated at temperatures from about 3 to 300^{0}K. Relative velocities between colliding particles of ^{4}He + ^{4}He as low as 60 m/sec could be reached. The apparatus was used to measure relative total cross sections for He + Ar and He + Ne over the velocity range of 120 to 1500 m/sec and 150 to 1400 m/sec, respectively. The velocity dispersion in the nozzle beam was sufficiently small to observe a glory oscillation in the He + Ar total cross section. The experimental results were compared to theoretical cross sections obtained from the exact solution of the Schroedinger equation for a model potential. The potential used was an ESMSV model with parameters reported by Chen, et al. (Diss. Abstr. Int., B)

4048 SCATTERING OF MOLECULAR HYDROGEN AND ITS ISOTOPES FROM CRYSTAL SURFACES. Rowe, R. G. Urbana, IL; Univ. of Illinois (1975). 232p. University Microfilms Order No. 75-14,162.

Thesis (Ph. D.).

Molecular beam scattering of a thermal beam of H_2 from vacuum cleaved (001) surfaces of MgO and LiF, and (111) surfaces of CaF_2 and BaF_2 has been examined. The scattering of He, D_2 and HD from MgO (001) has also been investigated. The angular distribution of scattered flux indicates strong molecular diffraction from these surfaces. These results indicate that the surface structures of the crystals agree with those of the corresponding bulk planes. In addition to elastic diffraction maxima, strong extra peaks have been observed for hydrogen and its isotopes. These extra peaks have been determined to be the result of a coherent scattering process in which energy is redistributed between the rotational and translational degrees of freedom of the molecule. The redistribution of energy in this transition occurs with no energy interaction with the crystal lattice. Qualitative estimates indicate that for HD scattering, the total flux of molecules undergoing rotational transitions is comparable to the flux into the strong first order elastic diffraction peaks. (Diss. Abstr. Int., B)

4049 PROTON-INDUCED L-SHELL X RAYS OF Pr, Sm, Eu, Gd, AND Dy. Abrath, F. G. Denton, TX; North Texas State Univ. (1974). 80p. University Microfilms Order No. 75-7023.

Thesis (Ph. D.).

Characteristic L-shell x rays of the five rare earths Pr, Sm, Eu, Gd, and Dy were studied in this work. The x rays were produced by ionization from 0.3 to 2.0 MeV protons. Total L-shell ionization and x-ray production cross sections were measured for Sm and compared to the BEA, CBEA and PWBA theories. Total L-shell ionization cross sections were measured for Pr, Eu, Gd, and Dy and compared to the BEA, CBEA, and PWBA. The CBEA and PWBA fit the samarium data well for both ionization and x-ray production cross sections. The BEA was generally 40 percent lower than the data. The CBEA and the PWBA also fit the ionization cross section data for Pr, Eu, Gd and Dy, while the BEA was generally 40 percent lower than the data. Also measured for all five elements were the following x-ray intensity ratios: L $alpha_{1,2}$/L $gamma_1$, L $alpha_{1,2}$/L $gamma_{2,3}$, L $gamma_1$/L $gamma_{2,3}$ and L $alpha_{1,2}$/Ll. The L $alpha_{1,2}$/Ll ratios were compared with the radiative width measurements of Scofield while the other three ratios were compared with the CBEA and PWBA. The experimental L $alpha_{1,2}$/L $gamma_{2,3}$ and L $gamma_1$/L $gamma_{2,3}$ ratios for all five elements exhibited a peak which was correctly predicted in shape and position by the PWBA. The CBEA predicted a less sharply defined peak in these ratios about 0.5 MeV higher than the data. The general shape and magnitude of the L $alpha_{1,2}$/L $gamma_1$ ratio were correctly predicted by both the CBEA and the PWBA. (Diss. Abstr. Int., B)

4050 APPLICATION OF LANDAU-ZENER FORMULA FOR THE RATIOS OF TARGET TO PROJECTILE K-SHELL VACANCY

PRODUCTION. Kubo, Hideo; Jundt, F. C.; Purser, K. H. (Rochester Univ., N. Y. (USA). Nuclear Structure Research Lab.). J. Phys. Soc. Jpn.; 37: No. 6, 1612-1614(Dec 1974).

The target (Z_2) and projectile (Z_1) K-shell vacancy creation cross sections were measured from high energy collisions of Ni and Br ions with various targets. The ratio of these cross sections was fitted to the formula deduced from the work of Landau and Zener. This formula is expressed in a simple form and depends only on the incident velocity and charges of target and projectile ions, although it contains a single parameter. By varying this parameter an excellent agreement was obtained. (auth)

4051 CHARGE TRANSFER REACTIONS OF 8 TO 160 eV CH_4^+. Ardelean, P.; Mercea, V.; Pamula, A. (Inst. of Stable Isotopes, Cluj). Rev. Roum. Phys.; 20: No. 3, 231-236(1975).

The charge transfer reactions of CH_4^+ ions with CH_4, CH_2D_2, CH_3D and CD_4 were studied in a perpendicularly type tandem mass spectrometer. The influence of the kinetic energy of incident ions on the secondary mass spectra is relatively small in all cases. An intermolecular isotopic effect is observed between the systems $CH_4^+ - CH_4$ and $CH_4^+ - CD_4$. In the $CH_4^+ - CH_2D_2$ and $CH_4^+ - CH_3D$ reactions an isotopic effect is observed in the elimination of H and D atoms by dissociative charge transfer. (auth)

4052 INFRARED RADIATION FROM H_2O, CO_2, OR NH_3 COLLISIONALLY EXCITED BY N_2, O, OR Ar. Dunn, M. G.; Skinner, G. T.; Treanor, C. E. (Calspan Corp., Buffalo). AIAA (Am. Inst. Aeronaut. Astronaut.) J.; 13: No. 6, 803-812(Jun 1975).

Results are reported of an experimental study to elicit the spectral infrared radiative properties of H_2O, CO_2, or NH_3 molecules that have been involved in a single high-energy collision with N_2, O, or argon. A pressure-driven reflected-shock tunnel was used to produce a 5.8 km/sec supply of N_2 molecules or a 4.3 km/sec supply of O atoms or a 5.4 km/sec supply of argon that subsequently impacted the target molecules. Experimental values of sigma/sub *//tau (excitation cross section/radiative lifetime) are presented for the wavelength regions 2.5-3.1 mum, 5.7-7.5 mum, 8.3-9.2 mum, 9.1-10.3 mum, 10.6-11.6 mum, 11.1-14.0 mum, and 8.3-14.0 mum for the N_2-H_2O collisions. Values of sigma/sub *//tau are also presented for the N_2-CO_2 collisions in the wavelength regions 4.28-4.34 mum, 8.3-9.2 mum, 9.1-10.3 mum, 10.6-11.6 mum, and 8.3-14.0 mum. In addition, values of sigma/sub *// tau are reported for the N_2-NH_3 interaction in the wavelength intervals 8.3-9.2 mum, 10.6-11.6 mum, and 8.3-14.0 mum. Experimental values of sigma/sub *//tau are also presented for the O-H_2O interaction in the wavelength intervals 2.46-3.13 mum, 5.67-7.45 mum, and 11.1-14.0 mum. A value of sigma/sub *//tau is given for Ar-H_2O collisions at 5.4 km/sec in the wavelength interval 5.67-7.45 mum. These experimental values of sigma/sub *//tau are compared with theoretical calculations of the effective values of sigma/sub *//tau for radiation in the given wavelength intervals. Using available values of the radiative lifetimes, values for sigma/sub */ were obtained. (auth)

4053 COMPOSITE MODEL DESCRIBING THE EXCITATION AND DE-EXCITATION OF NITROGEN BY AN ELECTRON BEAM. Kassem, A. E.; Hickman, R. S. (Univ. of California, Santa Barbara). AIAA (Am. Inst. Aeronaut. Astronaut.) J.; 13: No. 6, 770-775(Jun 1975).

Based on recent studies, the effect of re-excited ions in the emission of electron beam induced fluorescence in nitrogen has been estimated. These effects are included in the formulation of a composite model describing the excitation and de-excitation of nitrogen by an electron beam. The shortcomings of previous models, namely the dependence of the measured temperature on true gas temperature as well as the gas density, are almost completely eliminated in the range of temperatures and densities covered by the available data. (auth)

4054 NEUTRINO AND ANTINEUTRINO SCATTERING ON A HYDROGEN-LIKE ATOM. Gaponov, Yu. V.; Dobrynin, Yu. L.; Tikhonov, V. N. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 22: No. 2, 328-334(Aug 1975). (In Russian)

Cross sections are calculated for neutrino and antineutrino scattering on the 1s electron in a hydrogen-like atom: the elastic scattering cross section, the cross section for excitation of 2s, 2p states and states with main quantum number n, the ionization cross section. The ionization cross section in the region $E_\nu \sim \alpha Z mc^2$ is 2-3 times as much as the scattering cross section of a free electron. The effect does not depend on νe-scattering model. (2 tables, 1 figure) (auth)

4055 DETERMINATION OF INTERMOLECULAR POTENTIALS USING HIGH-ENERGY MOLECULAR BEAMS. Cross, R. J. Jr. (Yale Univ., New Haven). Acc. Chem. Res.; 8: No. 7, 225-230(Jul 1975).

A review is given of one of several methods for measuring intermolecular potentials, that of measuring high-energy (4 eV to 4 keV) total cross sections using molecular beams. Experimental techniques of beam formation and cross section measurement are discussed and an extensive list of systems studied by high energy elastic scattering is given, with literature references to each of the systems. (3 figures, 1 table, 47 references) (GHT)

4056 CHARGE TRANSFER IN PROTON-HYDROGEN COLLISIONS BY THE FADDEEV APPROACH. II. Sil, N.C.; Chaudhuri, J.; Ghosh, A.S. (Department of Theoretical Physics, Indian Association for the Cultivation of Science, Calcutta - 32, India). Phys. Rev. A 12: No. 3, 785-790 (Sept 1975).

A tractable form of the Faddeev equations as used by Chaudhuri *et al.* has been applied to the proton-hydrogen collision problem, retaining 1*s* and 2*s* states of the hydrogen atom in the expansion. To judge the effect of the proton interaction on the capture cross sections, calculations have been carried out with and without the inclusion of this interaction. The results for the 1*s*-2*s* capture and excitation cross sections are presented together with the elastic and ground-state capture cross sections. The present results have been compared with experimental findings and other theoretical results. (auth)

4057 RELATIVISTIC CALCULATION OF ELECTRON-ATOM SCATTERING BY SOLVING CLOSE-COUPLING EQUATIONS FROM THE DIRAC HAMILTONIAN. Chang, J. (Centre Européen de Calcul Atomique et Moléculaire, Bâtiment 506, 91 Orsay, France). Phys. Rev. A 12: No. 3, 791-795 (Sept 1975).

Numerical solutions of close-coupling equations from the Dirac Hamiltonian, without including the correlation and Lagrangian multiplier terms, are obtained by the method of outward and inward integrations, analogous to the one used in the nonrelativistic calculation. As an illustrative example, we present the results of electron-cesium scattering for $J = 0$. (auth)

4058 VIBRATIONAL-ROTATIONAL EXCITATIONS OF THE $(HeH)^+$ ION BY COLLISIONS WITH POSITRONS. Ray, S.; Barua, A.K. (Department of General Physics and X-rays, Indian Association for the Cultivation of Science, Calcutta 700032, India). Phys. Rev. A 12: No. 3, 796-800 (Sept 1975).

The vibrational-rotational excitations of the $(HeH)^+$ molecular ion by collisions with positrons have been studied by using a semiclassical first-order time-dependent perturbation theory based on the theory of Coulomb excitations of nuclei. The energy of the impinging positrons has been confined to a range for which the trajectories are nonpenetrating. Calculations have been performed for the vibrational excitations $0 \rightarrow 1$ and $0 \rightarrow 2$, accompanied by various rotational excitations. The results show the comparatively large contributions of the dipole term in the multipole expansion of the interaction potential to the vibrational excitation of the $(HeH)^+$ ion. (auth)

4059 ELASTIC SCATTERING OF ELECTRONS FROM LITHIUM ATOMS IN THE GLAUBER APPROXIMATION. Kumar, S.; Srivastava, M.K. (Department of Physics, University of Roorkee, Roorkee-247667, India). Phys. Rev. A 12: No. 3, 801-805 (Sept 1975).

The elastic scattering of electrons by lithium atoms is considered in the Glauber approximation using Franco's method for reducing the $(3Z + 2)$ -dimensional integral occurring in the amplitude for the scattering of charged particles by a Z-electron atom. It is found that the involvement of the inner electrons (those in the 1*s* state) causes very little change over the frozen-core Glauber calculations. (auth)

4060 SINGLE ELECTRON CAPTURE BY He^+ IN Mg AND Pb VAPORS. Baragiola, R.A.; Salvatelli, E.R. (Centro Atómico Bariloche, Instituto de Física Dr. José A. Balseiro, Comisión Nacional de Energía Atómica, Universidad Nacional de Cuyo, Bariloche, Argentina). Phys. Rev. A 12: No. 3, 806-810 (Sept 1975).

The single-electron capture cross section σ_{10} for He^+ ions on magnesium and lead vapors has been measured in the energy range 9–40 keV. The results are not in agreement with the conventional near-adiabatic criterion of Massey regarding the energy at which the cross sections σ_{10} are maxima. This is thought to be due to pseudocrossing of potential-energy curves. Cross sections for Mg are found to be larger than for Pb in spite of the fact that both targets have very similar ionization potentials for their outer electrons. (auth)

4061 ROTATIONAL EXCITATION OF HF IN SLOW COLLISIONS WITH He. Collins, L.A.; Lane, N.F. (Physics Department, Rice University, Houston, Texas 77001). Phys. Rev. A 12: No. 3, 811-815 (Sept 1975).

Low-energy rotational-excitation cross sections have been calculated from model-potential surfaces constructed to represent the interaction of atomic helium with hydrogen fluoride (HF). Quantum-mechanical solutions of the coupled equations were obtained including as many rotational states (open and closed) as needed for convergence. The behavior of the cross sections as a function of energy and the sensitivity to various model-potential surfaces are discussed. (auth)

4062 REDUCED MATRIX EQUATIONS FOR MANY-PARTICLE SCATTERING. I. ELECTRON-ATOM SCATTERING AT LOW ENERGIES. Hahn, Y.; Dirks, J.F. (Department of Physics, University of Connecticut, Storrs, Connecticut 06268); Chen, A.C. Phys. Rev. A 12: No. 3, 816-822 (Sept 1975).

The reduction method developed previously for many-particle scattering is applied here to derive new sets of coupled equations for electron scattering from atomic targets at low energies, fully taking into account the exchange effect and target distortions. The reduced matrix equations have simpler structure than the Faddeev-Watson equations, with the iteration kernels connected only in those channels which are explicitly taken into account. Scatterings by atomic hydrogen, helium, and lithium targets are considered, and the resulting formalism is compared with the earlier work of Faddeev and others. Various approximation procedures are described, and their applicability is tested on the electron-hydrogen scattering system. (auth)

4063 REDUCED MATRIX EQUATIONS FOR MANY-PARTICLE SCATTERING. II. PROTON-HYDROGEN CHARGE-EXCHANGE COLLISION AT HIGH ENERGIES. Chen, A.C. (Department of Physics, St. John's University, Jamaica, New York 11439); Hahn, Y. Phys. Rev. A 12: No. 3, 823-829 (Sept 1975).

The charge-exchange amplitude for the proton-hydrogen collision in the energy range 25–800 keV is calculated in the distorted-coupling Born approximation. The analysis is based on a reduced form of coupled equations of the Faddeev-Watson type, which was derived previously for the general many-particle scattering. The effective distortion potentials which appear in these equations are determined by minimization of the coupling between the elastic and inelastic excitation channels. The result provides a mathematical basis with which various previous calculations can be compared. The present study strongly supports the applicability and effectiveness of the reduced-matrix equations in treating the rearrangement processes. (auth)

4064 QUANTUM CALCULATIONS AND CLASSICAL INTERPRETATION OF A MODEL CURVE-CROSSING PROBLEM. Saxon, R.P.; Olson, R.E. (Molecular Physics Center, Stanford Research Institute, Menlo Park, California 94025). Phys. Rev. A 12: No. 3, 830-834 (Sept 1975).

Quantum close-coupled calculations are performed for a model two-state curve-crossing problem that was previously treated by a semiclassical analysis. Excellent agreement in the differential cross sections is obtained. The interference structure on the elastic cross sections can be physically interpreted by using only the classical deflection functions of the adiabatic and diabatic potential curves and the interferences between them. (auth)

4065 EXACT POINT-COULOMB CALCULATIONS OF DIFFERENTIAL CROSS SECTIONS OF ATOMIC-FIELD BREMSSTRAHLUNG. Dugne, J.J.; Proriol, J. (Laboratoire de Physique Nucléaire, Université de Clermont-Ferrand, 63170 Aubiere, France). Phys. Rev. A 12: No. 3, 842-845 (Sept 1975).

Angular bremsstrahlung cross sections are computed with a point-Coulomb potential. In this calculation, the Dirac equation is expanded in partial waves, the radial functions are the classical ones, and the amplitude is given in an analytical form. We give some curves for the energy range 50 keV–2.5 MeV and for the case $k/T \geq 0.8$, where screening effects are small (T is the kinetic energy of the incident electron, and k refers to the emitted photon). In particular, we consider the trip region of the bremsstrahlung spectrum at 1.84 MeV according to the experiment of Starek, Aiginger, and Unfried. The discrepancy between experimental and theoretical results is very large for low Z. (auth)

4066 TEN-CHANNEL EIKONAL TREATMENT OF ELECTRON–METASTABLE-HELIUM COLLISIONS: DIFFERENTIAL AND INTEGRAL CROSS SECTIONS FOR $2\,^{1,3}P$ AND $n=3$ EXCITATIONS FROM He ($2\,^{1,3}S$) AND THE (λ, χ, Π) PARAMETERS. Flannery, M.R.; McCann, K.J. (School of Physics, Georgia Institute of Technology, Atlanta, Georgia 30332). Phys. Rev. A 12: No. 3, 846-855 (Sept 1975).

We present a ten-channel eikonal treatment of the $2\,^{1,3}P$, $3\,^{1,3}S$, $3\,^{1,3}P$, and $3\,^{1,3}D$ excitations of atomic helium, initially in the $2\,^{1,3}S$ metastable states, by incident electrons with energy E (eV) in the range $5 \leq E \leq 100$. Integral and differential inelastic cross sections are obtained. Also, the angular-correlation parameters λ and χ, which respectively provide the relative population and relative phase of the collisionally excited P magnetic substates, and the circular polarization fraction Π of radiation emitted from these P states, are determined as functions of scattering angle θ and E. No measurements exist to date. The principle of detailed balance is explicitly demonstrated for the $2\,^1S$-$1\,^1S$ superelastic collision. (auth)

4067 HIGH RESOLUTION ANALYSIS OF COLLISION-INDUCED N^+_2 SPECTRUM. d'Incan, J.; Topouzkhanian, A. (Laboratoire de Spectrométrie Ionique et Moléculaire, Université Claude Bernard (Lyon I), 43, Boulevard du 11 November 1918, F-69621 Villeurbanne, France). J. Chem. Phys. 63: No. 6, 2683-2689 (15 Sept 1975).

A new band system ascribed to the N^+_2 molecule has been observed in the 3820–3920 Å region from hydrogen ion bombardment of nitrogen molecules. Particle energies up to 30 keV were displayed, at typical target pressures of 10^{-3}–10^{-2} torr. Beam currents as high as 25 μA have been measured. The emission proceeds from a $^4\Sigma^+_u \rightarrow X\,^2\Sigma^+_g$ transition. Rotational analysis of the (0,0) and (1,1) bands leads to the following molecular constants derived by least-squares technique: $T_e = 25\,467$ cm^{-1}, $\omega_e = 2398$ cm^{-1}, $\omega_e x_e = 14$ cm^{-1}, $B_e = 2.071$ cm^{-1}, $\alpha_e = 0.014$ cm^{-1}, $r_e = 1.078$ Å, $\nu_{00} = 25\,563.26$ cm^{-1}, and $3\epsilon = 0.69$ cm^{-1}. (auth)

4068 MULTIPLE POTENTIAL ENERGY SURFACES IN A SEMICLASSICAL STUDY OF MOLECULAR COLLISIONS. McLafferty, F.J.; George, T.F. (Department of Chemistry, The University of Rochester, Rochester, New York 14627). J. Chem. Phys. 63: No. 6, 2609-2619 (15 Sept 1975).

A semiclassical treatment of multiple (electronic) potential energy surfaces in molecular collisions is presented. Focusing on three surfaces, this treatment can be regarded as a generalization of a previous semiclassical treatment restricted to two surfaces [J. Chem. Phys. 56, 5637 (1972); 60, 2340 (1974)]. Suitable approximations lead to the formal simplicity of the elimination of nonadiabatic coupling terms by the analytic continuation of potential surfaces to their complex intersection points. The analysis first considers the semiclassical evaluation of the electronic propagator, which is a function of the nuclear path and appears inside a nuclear path integral. Then the nuclear path integral is evaluated by the method of steepest descent to yield S-matrix elements connecting initial and final states of a collision. The nuclear normalization for the S matrix is presented in its usual form, and possible corrections to this form are discussed. Finally, certain modifications of the treatment that might be necessary when dealing with different collision systems are mentioned. (auth)

4069 MERGING BEAMS STUDY OF THE $D^+(H_2,H)HD^+$ AND $H_2^+(D,H)HD^+$ REACTION MECHANISMS. Lees, A.B.; Rol, P.K. (Research Institute for Engineering Sciences and The Department of Chemical Engineering and Material Sciences, Wayne State University, Detroit, Michigan 48202). J. Chem. Phys. 63: No. 6, 2461-2465 (15 Sept 1975).

Lab-energy distributions of HD^+ ions formed in the $D^+(H_2,H)HD^+$ reaction were measured with high resolution for collisions with relative energy W in the range 1 eV $\leq W \leq$ 5 eV. In addition to observing the transition from long- to short-lived collision complexes and the relative growth of repulsive interactions, we also observed the possible participation of charge transfer in the entrance channel of the reaction. The charge transfer contribution was suggested by independent study of the $H_2^+(D,H)HD^+$ reaction, which follows predominantly direct interactions over the range 0.1 eV $\leq W \leq$ 10 eV. HD^+ ions formed in the $H_2^+(D,H)HD^+$ reaction have recoil energies in the same range as HD^+ ions which appear as a distinct shoulder in the $D^+(H_2,H)HD^+$ product distributions. For $W \geq 8$ eV, the $H_2^+(D,H)HD^+$ reaction yields a small fraction of H atoms which may be in an electronically excited state. (auth)

4070 SINGLE-COLLISION PRODUCTION OF QUASIMOLECULAR X RAYS IN HEAVY-ION ENCOUNTERS. Bell, F.; Betz, H.; Panke, H.; Spindler, E.; Stehling, W. (Sektion Physik, Univeristät München, 8046 Garching, Germany); Kleber, M. Phys. Rev. Lett. 35: No. 13, 841-844 (29 Sept 1975).

Remarkably large quasimolecular (molecular orbital) K-shell x-ray yields are found in 48-MeV S→Ne encounters, unequivocally indicating that production of molecular-orbital x rays can occur as a result of single-collision mechanisms. Gaseous and solid targets are found to give similar spectral shapes of the emitted continuum radiation. (auth)

4071 ION-BEAM IMPLOSION OF FUSION TARGETS. Clauser, M.J. (Plasma Theory Division, Sandia Laboratories, Albuquerque, New Mexico 87115). Phys. Rev. Lett. 35: No. 13, 848-851 (29 Sept 1975).

The performance of ion-beam—irradiated fusion targets consisting of a high-density spherical shell containing DT gas has been calculated. Breakeven with 10-MeV protons irradiating 1—2-mm-diam targets can be produced with a beam current around 10 MA. Results for various target sizes and other beam particles and voltages are also discussed. (auth)

4072 ROTATIONAL EXCITATION OF REACTION PRODUCTS: $C^+ + O_2 \rightarrow CO^+(A\,^2\Pi) + O$. Ottinger, Ch.; Simonis, J. (Max-Planck-Institut für Strömungsforschung, Göttingen, Germany). Phys. Rev. Lett. 35: No. 14, 924-927 (6 Oct 1975).

Chemiluminescent reactions between C^+ and O_2 were studied in a beam experiment. At $E_{c.m.} = 3.6$ eV, $CO^+(A\,^2\Pi)$ is formed with abnormally high rotational excitation. (auth)

4073 SOLUTION OF A SIMPLE INELASTIC SCATTERING PROBLEM. Knudson, S.K. (Department of Chemistry, Florida Technological University, Orlando, Florida 32816). Am. J. Phys. 43: No. 11, 964-968 (Nov 1975).

Simple examples of elastic scattering, typically from square wells,

serve as important pedagogical tools in discussion of the concepts and processes involved in elastic scattering events. An analytic solution of a model inelastic scattering system is presented here to serve in this role for inelastic events. The model and its solution are simple enough to be of pedagogical utility, but also retain enough of the important physical features to include most of the special characteristics of inelastic systems. The specific model chosen is the collision of an atom with a harmonic oscillator, interacting via a repulsive square well potential. Pedagogically important features of inelastic scattering, including its multistate character, convergence behavior, and dependence on an "inelastic potential" are emphasized as the solution is determined. Results are presented for various energies and strengths of inelastic scattering, which show that the model is capable of providing an elementary representation of vibrationally inelastic scattering. (auth)

4074 MODEL FOR MULTIPLE-COLLISION TRAJECTORIES IN NONREACTIVE ATOM–DIATOM COLLISIONS. Gottdiener, L. (School of Molecular Sciences, University of Sussex, Brighton, BN1 9QJ, England). J. Chem. Phys. 63: No. 6, 2433-2438 (15 Sept 1975).

The extent of the complex (multiple-collision) region (CR) is investigated for a classical nonreactive collinear atom–diatom system. A simple model to estimate the extent of the CR is given, based on the different roles the repulsive and attractive parts of the interaction potential V have in the collision. The model is extended to obtain more detailed information on the CR, such as the extent of m-collision regions within the CR. In the extended model, a multiple-collision trajectory is treated as a sequence of single-collision trajectories on a purely repulsive interaction potential V_r. The vibrational excitation produced by V and V_r is compared, and it is pointed out that if the motion of the system with V is to be described adequately by V_r, it is necessary that multiple-collision trajectories do not occur. (auth)

4075 THE O $K\alpha$ AND C $K\alpha$ EMISSION AND O K ABSORPTION SPECTRA FROM O_2 AND CO_2. IV. LaVilla, R.E. (Optical Physics Division, National Bureau of Standards, Washington, D.C. 20234). J. Chem. Phys. 63: No. 6, 2733-2737 (15 Sept 1975).

The oxygen and carbon $K\alpha$ emission and oxygen K absorption spectra of the molecular gases O_2 and CO_2 are reported. The spectra were obtained on two different spectrometers, both with single flat crystal configurations. All the emission spectra were excited by direct electron bombardment and are in fair agreement with an interpretation based on allowed electric dipole transitions between single vacancy states and molecular orbital theory for the molecules. The oxygen K absorption of O_2 and CO_2 is dominated by a strong resonance peak before the K-shell threshold which is interpreted as being due to the transition of oxygen K electrons to the first unoccupied valence orbital of the respective molecules. (auth)

4076 SEMICLASSICAL THEORY OF ROTATIONAL EXCITATION IN COLLISIONS OF DIATOMIC MOLECULES. Curtiss, C.F. (Theoretical Chemistry Institute, University of Wisconsin, Madison, Wisconsin 53706). J. Chem. Phys. 63: No. 6, 2738-2744 (15 Sept 1975).

In previous developments of the theory of rotational excitation in collisions of diatomic molecules, the cross sections have been expressed in terms of a generalized phase shift. In the present paper, the equations which determine the successive terms in a semiclassical expansion of the generalized phase shift are discussed and the first two equations are developed explicitly. (auth)

4077 NEGATIVE ION PROPERTIES OF p-BENZOQUINONE: ELECTRON AFFINITY AND COMPOUND STATES. Cooper, C.D.; Naff, W.T. (Department of Physics, University of Georgia, Athens, Georgia 30602); Compton, R.N. J. Chem. Phys. 63: No. 6, 2752-2757 (15 Sept 1975).

Bound and excited negative ion states of *para*-benzoquinone (PBQ) are studied from experiments involving collisions of electrons and cesium beams with PBQ. The electron affinity of PBQ was measured to be $1.89^{+0.2}_{-0.3}$ eV using the cesium collisional ionization technique. $PBQ^-(C_6H_4O^-_2)$ was the dominant negative ion observed following collisions of cesium beams with PBQ. Direct electron attachment to PBQ produced the fragment ions $C_5H_4O^-$, $C_5H_3O^-$, $C_4O_2H^-_2$, C_2HO^-, and C_2H^- as well as the parent $C_6H_4O^-_2$ ion. Our observations showed that the cross section for producing the metastable parent negative ion, $C_6H_4O^-_2$, peaks at 1.40±0.1 eV which is in disagreement with a previous value of 2.1 eV. Attachment of thermal electrons to PBQ at low pressure ($<10^{-4}$ mm Hg) was not observed. Compound negative ion states were observed to peak at 0.70, 1.35, and 1.90 eV using the SF_6 scavenger technique. The energies of these compound states agree qualitatively with the energies of the manifold of unfilled π^*orbitals. The long-lived state at 1.4 eV is attributed to either (a) direct attachment of the incident electron into the $^2b_{1u}$ orbital followed by internal conversion to the ground $^2B_{3g}$ of PBQ^- or (b) simultaneous excitation of a core electron and attachment of the incident electron into an excited orbital (i.e., core excited Feshbach resonance) as previously suggested. Evidence is presented for the former explanation. (auth)

4078 AUGER ANALYSIS OF THIN OXIDE FILMS ON Pb–In ALLOYS. Chou, N.J.; Lahiri, S.K.; Hammer, R. (IBM Thomas J. Watson Research Center, Yorktown Heights, New York 10598); Komarek, K.L. J. Chem. Phys. 63: No. 6, 2758-2764 (15 Sept 1975).

The composition and stability of thin oxide films (≤ 35 Å), thermally grown on Pb–In alloy substrates at room temperature and various oxygen pressures, were studied quantitatively by Auger electron spectroscopy. The results indicate that all oxide films are enriched in indium in varying amounts, depending on the alloy composition and oxygen pressure. For alloys containing more than 10 at.% In, the surface layer of the oxide consists of pure In_2O_3 only; for alloys of lower In concentrations a mixture of PbO and In_2O_3 is formed. The mixed oxide appears to be unstable since the Auger data monitored during vacuum storage are indicative of the reduction of PbO with attendant formation of additional In_2O_3 occuring near the alloy–oxide interface. (auth)

4079 ASYMPTOTIC FORM OF THE CHARGE-EXCHANGE CROSS SECTION IN THREE-BODY REARRANGEMENT COLLISIONS. Omidvar, K. (Theoretical Studies Group, NASA Goddard Space Flight Center, Greenbelt, Maryland 20771). Phys. Rev. A 12: No. 3, 911-926 (Sept 1975).

A three-body general-type rearrangement collision is considered where the initial and final bound states are described by hydrogenlike wave functions. The solution obtained is for the first Born approximation where the full interaction potential is taken into account. When the initial state is the ground state, it is shown that for $n/\mu Z \gg 1$, where n,μ, and Z are, respectively, the principal quantum number, the reduced mass, and the nuclear charge of the formed atom, the capture cross section at all incident energies and for capture into the s, p, and d angular momentum states behaves as $C/n^3 + O(1/n^5)$, where C depends on masses and charges of the particles, the final angular momentum, and the incident energy. An analytic expression for C is given. It is shown that for the low-lying levels the $1/n^3$ scaling law at all incident energies is only approximately satisfied. The only exception is for capture into the s states according to the Oppenheimer-Brinkman-Kramers approximation. The case for the symmetric collisions is considered and it is shown that for high n and high incident energy E, the cross section behaves as $1/E^3$. Zeros and minima in the differential cross sections are given in the limit of high n for electron capture by protons from atomic hydrogen, and for positronium formation by proton–atomic hydrogen collisions. (auth)

4080 COLLISIONAL PERTURBATIONS OF TIME-RESOLVED PHOTON SCATTERING FROM MOLECULAR LEVELS. Mukamel, S. (Department of Chemistry, Tel-Aviv University, Tel Aviv, Israel); Ben-Reuven, A.; Jortner, J. Phys. Rev. A 12: No. 3, 947-958 (Sept 1975).

A theoretical study is presented of the effects of collisional perturbations on the time-resolved resonant and near-resonant photon scattering from a molecular system. The photon counting rate is formulated in terms of tetradic Green's functions in Liouville space. The collisional and radiative damping effects are handled by an effective-Liouvillian formalism. The formal expressions are disentangled by invoking a series of successive approximations, assuming short correlation times of the thermal bath, neglecting relaxation processes in the ground electronic state, considering rotational relaxation as providing the dominant damping mechanism in the excited electronic manifold, specializing to weak electromagnetic fields, neglecting some off-resonance processes and disregarding collision-induced radiative processes. The photon counting rate is expressed as a triple convolution of the photon counting rate for the free molecule with the Doppler Gaussian profile and with a Lorentz profile. The latter incorporates purely collisional effects due to intrastate cross relaxations and proper T_2 processes. The theory accounts well for the recent experimental data of Williams, Rousseau, and Dworetsky on collisionally perturbed I_2 molecules. (auth)

4081 POSITRONIUM-HYDROGEN ELASTIC SCATTERING. Drachman, R.J. (Theoretical Studies Group, NASA/Goddard Space Flight Center, Greenbelt, Maryland 20771); Houston, S.K. Phys. Rev. A 12: No. 3, 885-890 (Sept 1975).

We have investigated the elastic scattering of positronium atoms by hydrogen atoms below the excitation threshold at 5.1 eV, limiting the investigation to the spin-zero (singlet) state of the two electrons. Nonresonant S-wave phase shifts have been obtained from normalizable trial functions by extracting the center-of-mass wave function and examining its spatial behavior. An effective-range expansion is fitted to the phase shifts and the previously obtained positronium-hydride bound-state energy to yield a scattering length $a \simeq 5.3a_0$ compared with Fraser's corrected exchange result, $a = 7.28a_0$ (a_0 is the Bohr radius). The stabilization method suggests that a resonance occurs at a scattering energy of 4.5 eV, about 0.6 eV below the excitation threshold. Using the complex rotation method, we have obtained evidence confirming the existence of the resonance and an estimate of its width of about 6×10^{-2} eV. (auth)

4082 ASSOCIATIVE IONIZATION IN COLLISIONS BETWEEN TWO EXCITED REACTANTS. Neynaber, R.H.; Magnuson, G.D. (IRT Corporation, P. O. Box 80817, San Diego, California 92138). Phys. Rev. A 12: No. 3, 891-894 (Sept 1975).

Absolute and relative cross sections were obtained for the associative ionization (AI) reaction $He^* + Ne^* \rightarrow HeNe^+ + e$ by a merging-beams technique over a range of interaction energy W from 0.01 to 10 eV. The He^* represents a composite of $He(2\,^1S)$ and $He(2\,^3S)$, and the Ne^* a composite of $Ne(3s\,^3P_2)$ and $Ne(3s\,^3P_0)$. This study represents the first direct evidence of AI for which both reactants are excited. Studies were also made of the possible AI reaction $Ne^* + Ar^* \rightarrow NeAr^+ + e$ from thermal energy to 10 eV. (auth)

4083 RADIATIVE CAPTURE AND RECOMBINATION IN ELECTRON-ATOM COLLISIONS. Hahn, Y. (Department of Physics, University of Connecticut, Storrs, Connecticut 06268). Phys. Rev. A 12: No. 3, 895-907 (Sept 1975).

A comprehensive theory of electron scattering from atoms and ions at high energies is formulated, incorporating the coupling of the scattering system to the radiation field. In particular, the photocapture process is discussed in detail, which can proceed either by a direct radiative capture or by dielectronic recombination following a radiationless capture into excited states. The latter process involves a collisional excitation of the inner-shell electrons of the target, followed by radiative decay of that excited state. The required sum over excitation probabilities to all the allowed bound states is estimated using the semiclassical projection operators and the single-particle model for the target system. A preliminary estimate of the cross sections for these modes of capture is obtained for the case of a hot-electron plasma interacting with highly ionized impurity ions. (auth)

4084 ELECTRON TRANSFER IN keV-ENERGY $^4He^{++}$ COLLISIONS. III. EXPERIMENTAL TESTS OF THE CLOSE-COUPLING CALCULATIONS FOR $^4He^{++}$-H(1s) COLLISIONS. Bayfield, J.E.; Khayrallah, G.A. (J. W. Gibbs Laboratory, Physics Department, Yale University, New Haven, Connecticut 06520). Phys. Rev. A 12: No. 3, 869-875 (Sept 1975).

Two experimental tests of the $^4He^{++}$-H(1s) close-coupling collision calculations were performed with a highy mass-resolved $^4He^{++}$ incident ion beam and an atomic hydrogen scattering target. The total single-electron-transfer cross section $\sigma_{21}(H)$ was measured for $^4He^{++}$ energies between 7 and 144 keV, with the results in better agreement with molecular-state calculations than with theory employing atomic states. Above 25 keV this cross section is 50% above values obtained by Shah and Gilbody for incident $^3He^{++}$ with the same collision velocity. Also measured was the cross section $\sigma_{21}^*(H)$ for single-electron transfer into the 2s state of He^+ using an ion-photon time-coincidence technique over the $^4He^{++}$ energy range 7 to 70 keV. These data differ with the corresponding $^3He^{++}$-H(1s) data of Shah and Gilbody at the higher energies. For $\sigma_{21}^*(H)$, the observed energy dependence as well as the magnitude at the lower energies are in marked disagreement with all close-coupling results. (auth)

4085 LARGE-ANGLE INELASTIC ELECTRON-HELIUM SCATTERING IN THE UNRESTRICTED GLAUBER APPROXIMATION. Kelsey, E.J.; Macek, J. (Behlen Laboratory of Physics, University of Nebraska, Lincoln, Nebraska 68508). Phys. Rev. A 12: No. 3, 1127-1131 (Sept 1975).

The work of Gau and Macek on large-angle inelastic electron-hydrogen scattering in the unrestricted Glauber approximation is extended to electron-helium scattering. "Unrestricted" in this context means that we do not make the additional approximation of purely transverse linear-momentum transfer. Once again, we find at large angles for $1\,^1S_0 \rightarrow 2\,^1P_1$ collision-induced transitions the electron-nucleus interaction dominates and has a q^{-4} behavior in the differential cross section. Further, we calculate the orientation parameter O_{1-00}. (auth)

4086 VIBRATIONAL RELAXATION OF HF AND DF DUE TO COLLISIONS WITH He AND O_2 IN SHOCK WAVES. Vasil'ev, G.K.; Makarov, E.F.; Papin, V.G. Sov. Phys.—Tech. Phys. 20: No. 2, 272-273 (Feb 1975).

The vibrational relaxation times for HF and DF due to collisions with He and O_2 are obtained by recording the IR emission behind a shock wave. The results are examined in the framework of the V–R, T energy transfer mechanism characteristic of hydrogen halide molecules. (auth)

Atomic Theory

Refer also to abstracts 3778, 3982, 4145, and 4493.

4087 TRIPLY EXCITED STATES OF THREE-ELECTRON ATOMIC SYSTEMS. Ahmed, M. (Department of Physics, University of Nebraska, Lincoln, Nebraska 68508); Lipsky, L. Phys. Rev. A 12: No. 4, 1176-1196 (Oct 1975).

A formalism is discussed whereby many-electron systems may be described by a great number of product functions of different configurations in a manageable way. Calculations are made to find triply excited energy levels of three-electron atomic systems, using products of hydrogenic functions with a Z equal to that of the nucleus. Results for the lowest $^2P^o$ and $^2S^e$ levels in the Li isoelectronic sequence, $Z = 1$ to 10, are presented. The results of calculations for the energies of $^2D^e$ triply excited states in He^- are also reported. The calculated energies are compared with available experimental and other theoretical values. Finally, the lowest $^2S^e$ and two lowest $^2P^o$ energy levels in the isoelectronic sequence are fitted by a $1/Z$ perturbation expansion. It is seen that this expansion can be used to estimate the energy levels of such states for higher nuclear charges. (auth)

4088 COMMENT ON THE DECAY CURVES OF HYDROGENLIKE ATOMS OBSERVED AT LONG TIMES FOLLOWING EXCITATION. Schectman, R.M. (Department of Physics, The University of Toledo, Toledo, Ohio 43606). Phys. Rev. A 12: No. 4, 1717-1718 (Oct 1975).

Explicit calculations demonstrate that cascade repopulation effects are a possible explanation of the $t^{-1.5}$ dependence in the decay of Ly-α radiation at long times after excitation observed recently by Braithwaite, Matthews, and Moore. Good agreement with all available experimental data is obtained with reasonable population models; excitation proportional to n^{-m} with $m = 2.2$–4 is indicated. (auth)

4089 ELECTRONIC CORRELATION STUDIES. III. Self-Correlated Field Method. Application to ^2S Ground State and ^2P Excited State of Three-Electron Atomic Systems. Lissillour, R.; Guerillot, C. R. (Univ. de Rennes, France). Int. J. Quant. Chem.; 9: No. 4, 627-634(Jul 1975).

The self-correlated field method is based on the insertion in the group product wave function of pair functions built upon a set of correlated "local" functions and of "nonlocal" functions. This work is an application to three-electron systems. The effects of the outer electron on the inner pair are studied. The total electronic energy and some intermediary results such as pair energies, Coulomb and exchange "correlated" integrals, are given. The results are always better than those given by conventional SCF computations and reach the same level of accuracy as those given by more laborious methods used in correlation studies. (auth)

4090 ATOMIC RESONANCES ABOVE THE TOTAL IONIZATION ENERGY. Doolen, G. (Physics Department of Cyclotron Institute, Texas A&M University, College Station, Texas 77843). Phys. Rev. A 12: No. 3, 1121-1122 (Sept 1975).

A rigorous result obtained using the theory associated with dilatation analytic potentials is that by performing a complex coordinate rotation, $r_j \rightarrow r_j e^{i\theta}$, on a Hamiltonian whose potential involves only pairwise Coulombic interactions, one can show that when $\theta = \pi/2$, no complex eigenvalues (resonances) appear whose energies have a real part greater than the total ionization energy of the atomic system. This appears to conflict with experimental results of Walton, Peart, and Dolder, who find resonance behavior above the total ionization energy of the H^- system and also the theoretical stabilization results of Taylor and Thomas for the same system. A possible resolution of this apparent conflict is discussed and a calculation to check its validity is proposed. (auth)

PHYSICS (ELECTROFLUID AND MAGNETOFLUID)

Refer also to abstract 3869.

4091 EXPERIMENTAL STUDY OF PRESSURE PROFILE ON A FULL AND CONDUCTING SPHERE IN PRESENCE OF A TRANSVERSE MAGNETIC FIELD. Bas, Jacky; Vives, Charles (Centre Universitaire d'Avignon, 84 (France)). C. R. Hebd. Seances Acad. Sci., Ser. A, B; 280: No. 13, 389-392(7 Apr 1975). (In French)

Experimental readings of pressure profile on full and conducting spheres in presence of a magnetic field transverse to the average direction of the flow of a conducting liquid. Applying of a magnetic field introduces a dissymmetry on the pressure distribution. Evolution of this dissymmetry, of the stagnation point pressure and of drag coefficient for $107 \leq Re \leq 13{,}450$ and $0 \leq M \leq 160$. (FR)

4092 APPLIED STUDY OF LAMINAR OSCILLATIONS OF A VISCOUS AND ELECTROCONDUCTOR LIQUID BY THE HARMONIC MOVEMENT OF ONE OF THE WALLS OF THE RECTANGULAR CHANNEL CONTAINING THE LIQUID, COMING UNDER THE INFLUENCE OF A UNIFORM INDUCED MAGNETIC FIELD. Vergnes, Jean (Centre Universitaire de Saint-Denis, 974 - Reunion (France)). C. R. Hebd. Seances Acad. Sci., Ser. A, B; No. 13, 385-387(7 Apr 1975). (In French)

Experimental results on the movement of an electroconductor fluid running in a rectangular channel under the influence of a uniform induced magnetic field are given. One of the two walls which are perpendicular to the field shows a harmonic movement defined by the formula $V_0 \cos \omega t$. The two other walls, highly conductive and parallel to the fields, are connected on the outside by a pure resistance. (FR)

4093 NONLINEAR PARALLEL RINGING OF MAGNETIZATION IN SUPERFLUID ^{3}He. Webb, R.A.; Sager, R.E.; Wheatley, J.C. (University of California at San Diego, La Jolla, California 92037). Phys. Rev. Lett. 35: No. 15, 1010-1013 (13 Oct 1975).

Experiments based on an analogy to the ac Josephson effect have shown in both ^{3}He-*A* and ^{3}He-*B* that a pairing theory of the superfluidity of ^{3}He is essentially correct. Additional observations of parallel ringing are not in agreement with the simple "pendulum models" used to describe nonlinear dynamic magnetic effects. (auth)

4094 NONSTEADY INTERACTION OF A PLASMA FLOW BEHIND A STRONG SHOCK WAVE WITH A MAGNETIC FIELD. Ostashev, V.E.; Maksimov, A.M.; Lebedev, E.F.; Kuznetsov, Yu.A.; Davydov, A.N. (Institute of High Temperatures, Academy of Sciences of the USSR). High Temp. 13: No. 1, 92-96 (Sept 1975).

The interaction of a shock-produced plasma in air with a transverse magnetic field has been studied experimentally (p=5 mm Hg, u_s=9 km/sec, B=2.5 T). Particular care is taken to create nearly one-dimensional interaction conditions to facilitate subsequent comparison with the calculations. It is found that with scattering taken into account the maximum value of the induced magnetic field is consistent with the calculated magnetic Reynolds number $Re_m \simeq 1$. Streak photographs and magnetic probes are used to pinpoint the inception in the shock wake of a narrow high-pressure zone in which the main bulk of the current is concentrated (the length of this zone is less than the length of the electrically conducting plug). A restructuring and appreciable retardation of the flow (velocity reduced to one half) are observed. (auth)

4095 CONTINUOUS SPECTRA EMITTED BY PARTICLES KNOCKED OUT BY AN ION BEAM FROM THE SURFACE OF A SOLID TARGET. Kiyan, T. S.; Gritsyna, V. V.; Logachev, Yu. E.; Fogel, Ya. M. (Kharkov State Univ.). JETP Lett. (USSR) (Engl. Transl.); 21: No. 1, 35-37(5 Jan 1975).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 21: No. 1, 77-81(5 Jan 1975).

Results are presented of an investigation of the continuous spectrum emitted by particles knocked out by an ion beam from the surface of a solid target. The hypothesis is advanced that the continuous spectrum is emitted by the knocked-out particles whose electron shells have experienced collective excitation in the process. (auth)

4096 PHASE TRANSITIONS IN SYSTEMS WITH A COUPLING TO A NONORDERING PARAMETER. Achiam, Y. (Department of Physics and Astronomy, Tel-Aviv University, Tel-Aviv, Israel); Imry, Y. Phys. Rev. B 12: No. 7, 2768-2776 (1 Oct 1975).

The renormalization-group method is applied to the analysis of phase transitions in systems where the order parameter s is coupled to a nonordering additional variable y. A variety of critical and tricritical behaviors or first-order transitions is found as a function of the physical variables and possible macroscopic constraints imposed on the system. For s^2y coupling, the correlation function of y was found to be governed by a correlation length which is proportional to that of the order parameter, and by a critical index η_y, $\eta_y = 2 - 2\alpha$; α here is the specific-heat exponent of the appropriate unconstrained system. The singular part of the susceptibility, χ_y, has a critical exponent equal to α, the true specific-heat exponent. When the coupling is s^2y^2, a weaker singularity of χ_y appears. The crossover between this behavior and the one typical to s^2y coupling is calculated. $\langle y \rangle$ has a singular part with an exponent $1-\alpha$, in the unconstrained case. The breakdown of the scaling law related to the correlation function of y in the constrained case is discussed. (auth)

4097 HARD-SPHERE BOSE GAS: SELF-CONSISTENT-FIELD APPROXIMATION. Lobo, R. (Departmento de Física e Ciência dos Materiais, Instituto de Física e Química de São Carlos, Universidade de São Paulo, 13560-São Carlos, São Paulo, Brazil). Phys. Rev. B 12: No. 7, 2640-2643 (1 Oct 1975).

The elementary excitation spectrum of a hard-sphere Bose gas is calculated based on the self-consistent-field approximation. The hard-core diameter is left as an adjustable parameter of the theory. The results are in fairly good agreement with the experimental data for liquid helium. (auth)

4098 CONJUGATE VARIABLES AND A VARIATIONAL PRINCIPLE IN SUPERFLUID HELIUM. Lhuillier, D.; Francois, M.; Karatchentzeff, M. (Laboratoire d'Aerodynamique, bâtiment 502, Campus Universitaire, 91405 Orsay, France). Phys. Rev. B 12: No. 7, 2656-2666 (1 Oct 1975).

It is shown that the Landau two-fluid equations may be thought of as the Hamilton equations of two pairs of conjugate variables. This result is used to study the vortex dynamics and to obtain a method for generalizing the Landau equations when the superfluid velocity is no longer irrotational. These generalized equations are also derived from a variational principle, using a slightly modified form of Lin's constraint. Lastly we analyze the consequences on the Josephson effect of the existence of two pairs of conjugate variables. (auth)

4099 DYNAMIC SPIN SUSCEPTIBILITY IN THE *A* PHASE OF SUPERFLUID ^{3}He IN THE HYDRODYNAMIC REGIME. Maki, K. (Department of Physics, University of Southern California, Los Angeles, California 90007); Ebisawa, H. Phys. Rev. B 12: No. 7, 2667-2675 (1 Oct 1975).

The effect of the quasiparticle lifetime on the dynamic spin susceptibility in the *A* phase of superfluid ^{3}He is studied theoretically based on a microscopic model. The quasiparticle lifetime is assumed to be due to the scattering from randomly distributed scattering centers. The dynamic susceptibility has poles in the low-frequency region, which describe the magnetic resonance. The real part of the resonance frequency agrees with that obtained previously by Leggett in the hydrodynamic regime. Furthermore, a spin-conserving scattering introduces a nonvanishing width, which is consistent with recent measurements. (auth)

4100 CONDENSATION OF He^3 ATOMS ONTO QUANTIZED VORTEX LINES IN SUPERFLUID HELIUM. Ostermeier, R.M.; Yarmchuk, E.J.; Glaberson, W.I. (Department of Physics, Rutgers University, New Brunswick, New Jersey 08903). Phys. Rev. Lett. 35: No. 14, 957-960 (6 Oct 1975).

We have measured the mobility of positive and negative ions trapped on vortex lines in He^3-He^4 solutions at temperatures from 0.3 to 1.6 K. Abrupt changes in the mobility at certain critical temperatures are interpreted as being associated with the condensation of He^3 atoms onto the vortex cores. The dependence of the critical temperature on the bulk He^3 concentration is found to be in good agreement with a simple condensation theory. (auth)

PHYSICS (HIGH-ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 4290.

4101 (BNL-20465) SEARCH FOR FRACTIONALLY CHARGED QUARKS AT ISABELLE. Foley, K. J.; Meadows, B. T. (Brookhaven National Lab., Upton, N. Y. (USA)). 1975. 11p. (CONF-750737-2). Dep. NTIS $4.50.

From proceedings of the ISABELLE summer study; Upton, New York, USA (14 Jul 1975).

A relatively simple experiment is proposed which is sensitive to conventional quarks of charge 1/3 or 2/3e and mass less than 200 GeV. The experiment uses a modest amount of conventional equipment, no magnetic momentum analysis, and in a period of one week will achieve a sensitivity of 10^{-36}cm^2 to isotropic quark production. Despite the experimental simplicity, the signature provided by a fractionally charged quark should be unambiguous. The method and apparatus are described, background and counting rates are discussed, and finally a cost estimate is given for this experiment. (JFP)

4102 (ERDA-83) REPORT OF THE 1975 SUBPANEL ON NEW FACILITIES OF THE HIGH ENERGY PHYSICS ADVISORY PANEL. (Energy Research and Development Administration, Washington, D. C. (USA)). Jul 1975. 30p. Dep. NTIS $5.00.

The topics discussed are new developments in particle physics, physics at the proposed new facilities, technical considerations, recommendations and comments, and the impact of alternative funding levels. (JFP)

Electromagnetic

4103 (NP-20526, pp 62-64) MEASUREMENTS OF POLARIZED TARGET ASYMMETRY FOR π^+ AND π^0 PHOTOPRODUCTION AT PHOTON ENERGIES BETWEEN 0.3 AND 1.0 GeV. Fukushima, M. (Nagoya Univ., Japan); Horikawa, N.; Kajikawa, R. 1974.

In Institute for Nuclear Study annual report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

4104 (NP-20526, pp 64-65) EXPERIMENTAL STUDY OF SINGLE CHARGED PION PHOTOPRODUCTION FROM COMPLEX NUCLEI. Baba, K. (Hiroshima Univ.); Endo, I.; Fujisaki, M.; Kadota, S.; Sumi, Y.; Fukii, H.; Murata, Y.; Murakami, A.; Noguchi, S. 1974.

In Institute for Nuclear Study annual report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

4105 (SLAC-185) ELECTRON SCATTERING OFF HYDROGEN AND DEUTERIUM AT 50^0 AND 60^0. Atwood, W. B. (Stanford Linear Accelerator Center, Calif. (USA)). Jun 1975. Contract E(04-3)-515. 251p. Dep. NTIS $7.50.

Thesis.

The inelastic scattering of electrons for both protons and neutrons has been measured at scattering angles of fifty and sixty degrees and for incident energies between 6.5 GeV and 19.5 GeV. Elastic scattering from protons was also observed. The measurements were made at the Stanford Linear Accelerator Center using the 1.6-GeV spectrometer located in End Station A. The experimental techniques used in making the measurements are detailed. The resulting cross sections are large, indicative of a charged point-like substructure within the nucleon and match the extrapolation from previous measurements to the kinematic region to within forty percent. The measurements are found to be compatible with some existing theoretical expectations. The W_1 structure function is not found to "scale" in previously suggested scaling variables. The introduction of propagator scale breaking is investigated and shown to be compatible with the measurements. An alternative scaling variable is proposed in which W_1 is found to scale. The elastic scattering measurements are consistent with an inverse fourth power dependence on four-momenta transfer. The measured neutron-proton ratio is in agreement with previous measurements. (55 figures, 27 tables) (auth)

4106 RADIATIVE DECAYS OF η AND η' AS PROBES OF QUARK CHARGES. Chanowitz, M.S. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. Lett. 35: No. 15, 977-980 (13 Oct 1975).

Radiative decays of η and η' allow us to test the color hypothesis and to distinguish between fractional- and integral-charge quark models. Accurate measurements of $\eta \to \gamma\gamma$ and $\eta' \to \pi^+\pi^-\gamma$ are essential to test the analysis and the preliminary conclusion, which favors the three-color model with fractional charges. (auth)

4107 QUEST FOR THE MAGNETIC MONOPOLE. Carrigan, R.A. Jr. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). Phys. Teacher 13: No. 7, 391-398 (Oct 1975).

A brief review is given of the properties of the magnetic monopole and of the experimental efforts to detect the postulated particle. (AIP)

4108 ROLE OF HEAVY VECTOR MESONS IN HADRONIC PHOTOABSORPTION. Lebedev, A.I. (P. N. Lebedev Physics Institute, USSR Academy of Sciences). JETP Lett. 21: No. 11, 323-324 (5 June 1975).

Allowance for the ψ particles improves the agreement between experiment and the prediction of the vector-dominance model for hadronic absorption of photons. An estimate is obtained of the total cross section for the interaction of hypothetical *D* particles with nucleons. (auth)

4109 e^+e^- — HADRONS TOTAL CROSS SECTIONS AND THE PARTON-ANTIPARTON INTERACTIONS. Muta, T. (Kyoto Univ. (Japan). Research Inst. for Fundamental Physics); Higashijima, K.; Uematsu, T. Prog. Theor. Phys. (Kyoto); 53: No. 1, 200-216(Jan 1975).

The rise of the factor $R = \sigma(e^+e^- \to \text{hadrons})/(4\pi\alpha^2/3s)$ for energies available in recent experiments is explained within the framework of the parton field theory. Assuming that the electromagnetic current couples minimally to the parton fields, we find that contributions to $\sigma(e^+e^- \to \text{hadrons})$, due to the parton-antiparton interactions, dominate over the so-called light-cone contribution, at least in the energy region available at present. We show within the pole approximation for partons that the factor R is bounded by 5 times ordinary quark-parton predictions for R. Experimental data on R are well reproduced by a suitable choice of the parton-antiparton interaction term. A comment is directed toward a possible connection of the absence of isolated free partons to the "serotinous" scaling in the process $e^+e^- \to$ hadrons. (auth)

4110 SEARCH FOR STRUCTURE IN THE γ-RAY SPECTRA FROM $\bar{p}d$ AND $\bar{p}p$ ANNIHILATIONS AT REST. Kalogeropoulos, T.E.; Michael, D.N. (Department of Physics, Syracuse University, New York 13210); Lowenstein, D.I.; Nathan, A.M.; Samios, N.P.; Schwarzschild, A.Z. Phys. Rev. Lett. 35: No. 13, 824-827 (29 Sept 1975).

The γ-ray spectra from annihilations at rest have been measured with a 10-in.$\times$10-in.-diam NaI(Tl) detector. The resolution of the system was $\sim$15% for γ-ray energies between 50 and 200 MeV. No clear evidence is found for monoenergetic γ rays with intensities greater than 1 per 30 annihilations. (auth)

4111 PROTON-ANTIPROTON ANNIHILATIONS INTO FOUR KAONS JUST ABOVE THRESHOLD. Schultz, J.; Price, L.R.; Burns, R.R.; Condon, P.E.; Donahue, J.; Dorfan, J.; Mandelkern, M.; Smith, D. (Department of Physics, University of California, Irvine, California 92664). Phys. Rev. D 12: No. 3, 644-650 (1 Aug 1975).

Cross-section limits are presented for proton-antiproton annihilation into all possible four-kaon final states in the region from threshold to 1.1 GeV/c lab momentum. Comparisons are made with cross sections for other four-body final states. It is shown that, based on phase-space considerations, the four-neutral-kaon final state manifests an anomalously high relative rate, suggesting the possible influence of a threshold enhancement. (auth)

Weak

4112 (ANL/HEP-CP-75-38) INCLUSIVE LOOK AT nu p AND nu n CHARGED-CURRENT REACTIONS BELOW 6 GeV. Barish, S. J.; Derrick, M.; Barnes, V. E. (Argonne National Lab., Ill. (USA); Purdue Univ., Lafayette, Ind. (USA)). 1975. 30p. (CONF-750853-3). Dep. NTIS $4.50.

From symposium on lepton and photon interactions; Stanford, California, USA (21 Aug 1975).

A study is made of inclusive charged-current nu p and nu n reactions by summing exclusive reactions. A broad-band neutrino beam of energies up to 6 GeV/c is used. Both the nu n and nu p total cross sections are found to rise with energy, and the neutron-to-proton cross section ratio is measured to be 1.40 +- 0.31 for E/sub nu/ greater than 2 GeV. The X and Y distributions and the cross sections for quasi-elastic scattering, single pi, 2 pi, and 3 pi production are discussed. The results given are preliminary. (JFP)

4113 (ANL/HEP-CP-75-39) ANTINEUTRINO-PROTON INTERACTIONS IN THE 15-FOOT BUBBLE CHAMBER. Barish,

S. J.; Derrick, M.; Dombeck, T. (Argonne National Lab., Ill. (USA)). 1975. 26p. (CONF-750853-1). Dep. NTIS $5.00.

From symposium on lepton and photon interactions; Stanford, California, USA (21 Aug 1975).

From 24,000 pictures of the Fermilab 15-foot hydrogen bubble chamber exposed to a broad band anti nu beam, there were 89 anti nu p yields $mu^+ + X^0$ events with a total momentum in the charged tracks greater than 5 GeV/c obtained. The techniques used to identify the muon are discussed, and the anti nu energy is estimated. The charged particle multiplicity distributions and the mean pi^0 multiplicity are presented. The semi-inclusive X, Y, Z, Q^2 and W distributions are compared with model predictions. The rate of strange particle production is measured. No evidence was found for charm particle production. (auth)

4114 MEASUREMENT OF THE AXIAL VECTOR AND VECTOR FORM FACTOR RATIO IN THE BETA DECAY OF THE LAMBDA HYPERON. Zack, D. M. Pittsburgh; Carnegie-Mellon Univ. (1975). 73p. University Microfilms Order No. 75-17,851.

Thesis (Ph. D.).

The ratio of the axial vector and vector form factors was measured for the beta decay of the LAMBDA hyperon, LAMBDA yields pe$^-$ anti nu. A sample of 262 unpolarized LAMBDA beta decays was collected from an exposure that contained 400,000 photographs of a stopping K^- meson beam in the Michigan-Argonne 40 in propane bubble chamber. The ratio of the form factors was estimated through the method of maximum likelihood. The distribution functions that were used to construct the likelihood function were functions of the two values of the kinetic energy of the proton in the rest frame of the LAMBDA hyperon. These distribution functions were generated through Monte Carlo methods with contributions to the hadronic current from the vector, weak magnetism, and axial vector terms. The maximum likelihood estimates that were obtained for positive and negative values of the ratio of the axial vector and vector form factors were 0.61/sub -0.12//sup +0.15/ and -0.55/sub -0.14//sup +0.11/ respectively. The small number of events did not permit the determination of the sign of the ratio in this experiment. (Diss. Abstr. Int., B)

4115 BOUND ON THE K_{l3} DECAY PARAMETERS USING $K\pi$ PHASE SHIFTS. Bunaciu, D. (Univ. of Bucharest). Rev. Roum. Phys.; 20: No. 2, 201-204(1975).

A bound on the parameters characterizing the decay of a K meson into a pion and a pair of leptons is evaluated making use in addition to some theoretical hypothesis already used in that problem, of the experimental data on the $K\pi - K\pi$ phase shifts. (auth)

4116 ψ (3684) RADIATIVE DECAYS TO HIGH-MASS STATES. Feldman, G.J.; Jean-Marie, B.; Sadoulet, B.; Vannucci, F.; Abrams, G.S.; Boyarski, A.M.; Breidenbach, M.; Bulos, F.; Chinowsky, W.; Friedberg, C.E.; Goldhaber, G.; Hanson, G.; Hartill, D.L.; Johnson, A.D.; Kadyk, J.A.; Larsen, R.R.; Litke, A.M.; Lüke, D.; Lulu, B.A.; Lüth, V.; Lynch, H.L.; Morehouse, C.C.; Paterson, J.M.; Perl, M.L.; Pierre, F.M.; Pun, T.P.; Rapidis, P.; Richter, B.; Schwitters, R.F.; Tanenbaum, W.; Trilling, G.H.; Whitaker, J.S.; Winkelmann, F.C.; Wiss, J.E. (Lawrence Berkeley Laboratory and Department of Physics, University of California, Berkeley, California 94720). Phys. Rev. Lett. 35: No. 13, 821-824 (29 Sept 1975).

We present experimental evidence for the existence of the decay ψ (3684) $\rightarrow \gamma\chi$, $\chi \rightarrow 4\pi^*$, $6\pi^*$, $\pi^+\pi^-K^+K^-$, $\pi^+\pi^-$, and K^+K^-. There is clear evidence for at least two χ states, one at 3.41 ± 0.001 GeV/c^2 and the other at 3.53 ± 0.02 GeV/c^2. The χ (3410) decays into $\pi\pi$ and KK and thus must have even spin and parity. (auth)

Strong (Baryon-induced)

Refer also to abstracts 4383 and 4384.

4117 (CONF-750858-4) INCLUSIVE NEUTRAL PARTICLE PRODUCTION. Kahn, S. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). 1975. 6p. Dep. NTIS $4.00.

From meeting of the ASP division of particles and fields; Seattle, Washington, USA (27 Aug 1975).

Results of recent inclusive neutral particle production experiments are compared to existing experimental results. These experiments range from 15 to 2000 GeV/c in laboratory beam momentum and use pi^-, pi^+, p and anti p beams. (auth)

4118 (COO-3130-TB-211) ANGULAR DISTRIBUTIONS OF ANTI pp YIELDS pi^0pi^0 AND ANTI pp YIELDS pi^0eta^0 AT 1.752 GeV/c. DeMarzo, C.; Guerriero, L.; Posa, F. (Brown Univ., Providence, R. I. (USA). Dept. of Physics). 1973. 33p. (CONF-7406110-1; CONF-740713-42). Dep. NTIS $4.75.

From symposium on antinucleon-nucleon interactions; Prague, Czechoslovakia (24 Jun 1974).

An experiment was performed to measure the angular distributions in the reactions anti pp yields pi^0pi^0 and yields pi^0eta^0 at an incident anti p momentum of 1.752 GeV/c. Structure is seen in the angular distributions for both reactions. These data are combined with those of Eisenhandler et al., on anti pp yields pi^+pi^- to determine the angular distributions in the states I/sup G/ equals 0^+ and I/sup G/ equals 1^+; pronounced structure is seen in both states which differ significantly from that of pi^0eta^0 (I/sup G/equals 1^-). (auth)

4119 (CRN/HE-75-2) ANALYSIS OF TWO-PRONG EVENTS IN ANTIPROTON-PROTON INTERACTIONS AT 5.7 GeV/c. Braun, H.; Gerber, J. P.; Maurer, G.; Michalon, A.; Schiby, B.; Strub, R.; Chew-Mettel, B.; Ouannes, C.; Strachman, Z. (Centre National de la Recherche Scientifique, 67-Strasbourg (France). Centre de Recherches Nucleaires). 1975. 36p. Dep. NTIS (US Sales Only) $5.00.

A study of elastic scattering, one pion production and annihilation reactions in $\bar{p}p$ interactions at 5.7 GeV/c was carried out, from the two prong events, obtained in the hydrogen bubble chamber exposed at CERN. Single particle distributions for the reactions $\bar{p}p \rightarrow \bar{p}p\pi^0$, $\bar{p}p \rightarrow \bar{p}n\pi^+$ and $\bar{p}p \rightarrow p\bar{n}\pi^-$ are presented. The study of the squared momentum transfer distributions with and without charge exchange in the cross channel shows different behavior of the slope parameters versus the mass of the produced ($N\pi$) system. The cross sections for isobar production and for diffractive dissociation in the one pion production reactions are obtained from a detailed Dalitz plot analysis. The results of the analysis of the decay angular distributions for the N(1510) and for the N(1680) produced in these reactions are in agreement with $J = 3/2$ and $J = 5/2$ assignment, respectively. The cross sections of the annihilation reactions $\bar{p}p \rightarrow \pi^+\pi^-$ and $\bar{p}p \rightarrow \pi^+\pi^-\pi^0$ are determined. Finally, some aspects of the mass distributions for the last reaction are given. (auth)

4120 INCLUSIVE Δ^{++} PRODUCTION IN π^+p AND pp INTERACTIONS AT 100 GeV/c AND THE AVERAGE MULTIPLICITY OF $\pi^+\pi^-$ SCATTERING. Erwin, J.; Kass, R.D.; Klems, J.H.; Ko, W.; Lander, R.L.; Pellett, D.E.; Yager, P.M. (Department of Physics, University of California, Davis, California 95616); Alston-Garnjost, M. Phys. Rev. Lett. 35: No. 15, 980-982 (13 Oct 1975).

Inclusive $\Delta^{++}(1236)$ production in π^+p and pp interactions is consistent with one-pion exchange. The average charged multiplicity recoiling from the Δ^{++} is studied as a function of missing mass, M^2, for both interactions. (auth)

4121 OBSERVATION OF Pt^0 MESONS WITH LARGE TRANSVERSE MOMENTUM IN HIGH ENERGY PROTON-PROTON COLLISIONS. Blumenfeld, B. J. New York; Columbia Univ. (1974). vp. Columbia Univ., Irvington-on-Hudson, NY. Refer to Nevis Report No. 202.

Thesis (Ph. D.).

An experiment was performed to study the production of large transverse momentum pi^0's (2.5 less than P/sub perpendicular/ less than 9 GeV/c) in the inclusive reaction p + p yields pi^0 + anything. Measurements were made near 90^0 at the CERN Intersecting Storage Rings at five center of mass energies (root s equals 23.5, 30.6, 44.8, 52.7, and 62.4 GeV). At large P/sub perpendicular/, the invariant cross sections are seen to vary with s and P/sub perpendicular/, in good agreement with a fit of the form AP/sub perpendicular/sup -n/F(P/sub perpendicular//root s), with n approximately 8 and F(P/sub perpendicular//root s) approximately exp(-26P/sub perpendicular//root s). (Diss. Abstr. Int., B)

4122 EIKONAL MODELS OF DIFFRACTIVE AND NONDIFFRACTIVE PARTICLE PROCESSES. Soh, K. S. Providence, RI; Brown Univ. (1974). 134p. University Microfilms Order No. 75-9243.

Thesis (Ph. D.).

The physical pictures and predictions of various eikonal models are compared with current NAL-ISR proton-proton scattering data. A simple solvable model is examined to exhibit an eikonal cancellation when graphs more complicated than noninteracting towers are exchanged. This computation also provides an example of the negative sign of the correction in the approach of the total cross section to its asymptotic value. A generalized eikonal model to include both diffractive and nondiffractive particle processes is constructed in the context of the modified phi^3 field theory. In the local sense--at a fixed energy--Blankenbecler's theorem is explicitly demonstrated. In the opposite global sense, if the rate of the opening of new diffractive channels is smaller than a certain value, particle production is mainly nondiffractive. However, if the rate is larger than this critical value, the diffractive process generates sufficiently strong absorption to change the physical picture from a Pomeron-like one to that of black-disk scattering. (Diss. Abstr. Int., B)

4123 MULTIPARTICLE PRODUCTION IN PROTON--PROTON COLLISIONS AT 205 GeV/c. Kafka, T. Stony Brook,

NY; State Univ. of New York (1974). 325p. University Microfilms Order No. 75-16,202.

Thesis (Ph. D.).

Data from an exposure of the 30 inch hydrogen bubble chamber to the 205-GeV/c proton beam at the Fermi National Accelerator Laboratory represent an unbiased sample of 5200 completely measured and reconstructed events. An approximate scaling of the multiplicity distributions in the missing mass variable was observed in the reaction p + p yields p + X. The multiplicity associated with the transverse momentum p/sub T/ of the outgoing proton in the reaction p + p yields p + X and of the negative secondary in the reaction p + p yields pi⁻ + X is also investigated. Both the average center-of-mass (CM) energy and the single particle distributions in x and in the transverse momentum of the identified outgoing proton in the reaction p + p yields p + X are discussed both in the inclusive and semi-inclusive data samples. The inclusive and semi-inclusive single particle rapidity distributions for both negative and positive pions are displayed. The distributions are corrected for the nucleon and kaon contamination in a statistical way whenever possible. The results are compared with data at other energies and conclusions concerning scaling are drawn. The pion distributions in p/sub T²/, as well as the pion average transverse momentum as a function of the x variable, the rapidity, and the multiplicity are shown. The cross section for the hemisphere multiplicities f and b are given and their fluctuation, [(f-b)²], as well as the correlation, [f(b)], are studied. The event-to-event fluctuations in phase space (after T. Ludlam, R. Slansky, Phys. Rev. D8 (1973), 1408) are investigated. The average dispersion in rapidity is then displayed as a function of multiplicity. (Diss. Abstr. Int., B)

4124 ZEROS OF TRIPLE SCATTERING PARAMETERS AND SPIN–PARITY DETERMINATION OF A RESONANCE. Ion, D. B. (Joint Inst. for Nuclear Research, Dubna, USSR); Topor, V. Rev. Roum. Phys.; 20: No. 3, 283-297(1975).

A new method for spin-parity determination of a resonance is presented. This method is based on the triple scattering experiments in the resonance energy region. It shows that, if one of the triple scattering parameters: $a(\theta)$, $A(\theta)$ or $\beta(\theta)$ for $0° \leq \theta \leq 180°$ is measured, then the spin and parity of resonance is unambiguously determined by the number of zeros and the sign of these parameters in different angular intervals. (auth)

4125 FINAL-STATE INTERACTION OF TWO NUCLEONS IN THE REACTION pd → ppn. Golovin, B. M.; Lykasov, G. I.; Khamraev, F. Sh. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 22: No. 2, 312-316(Aug 1975). (In Russian)

Contribution from the NN final-state interaction in single and double collisions is analyzed for the reaction pd → ppn. Results of numerical calculations for the differential cross sections at T = 585, 600 MeV are presented and compared with the experimental data obtained at these energies. (4 figures) (auth)

4126 CHARGE DISPERSION AND RECOIL PROPERTIES AT A=131 FROM THE INTERACTION OF ^{197}Au WITH 11.5- AND 300-GeV PROTONS. Yu, Y.W.; Porile, N.T. (Department of Chemistry, Purdue University, Lafayette, Indiana 47907). Phys. Rev. C 12: No. 3, 938-947 (Sept 1975).

Cross sections and thick-target recoil properties of five nuclides with A=131 as well as those of a number of neighboring nuclides have been determined for the interaction of ^{197}Au with 11.5-GeV protons. The charge dispersion at A=131 has a single peak at $Z_A - Z = -3.5$ and the total isobaric cross section is 8.9±0.8 mb. The ranges indicate that only ~2% of this value can be ascribed to fission, the bulk of the cross section involving a deep spallation process. Similar data have been obtained at 300 GeV. Within the limits of error the results are the same at both energies. The systematics of deep spallation reactions are examined. (auth)

4127 EXCITATION OF HIGH-ENERGY PROTONS INTO LOW-MASS STATES IN p-d INTERACTIONS. Akimov, Y.; Cool, R.; Golovanov, L.; Goulianos, K.; Gross, D.; Melissinos, A.; Malamud, E.; Mukhin, S.; Nitz, D.; Olsen, S.; Sticker, H.; Takhtamyshev, G.; Tsarev, V.; Yamada, R.; Zimmerman, P. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). Phys. Rev. Lett. 35: No. 12, 763-766 (22 Sept 1975).

We have measured p-d inelastic scattering at small momentum transfer by detecting the slow-recoil deuterons from a deuterium-gas-jet target. The coherent diffraction dissociation of protons on deuterons was studied in the region $0.03 < |t| < 0.07$ (GeV/c)², $1.4 < M_x^2 < 4$ GeV², and for energies from 50 to 275 GeV. In this region, the diffractive cross section exhibits structure and is dominated by an enhancement at $M_x^2 \sim 1.9$ GeV². (auth)

4128 DIFFRACTION DISSOCIATION OF HIGH-ENERGY PROTONS IN p-d INTERACTIONS. Akimov, Y.; Cool, R.; Golovanov, L.; Goulianos, K.; Gross, D.; Melissinos, A.; Malamud, E.; Mukhin, S.; Nitz, D.; Olsen, S.; Sticker, H.; Takhtamyshev, G.; Tsarev, V.; Yamada, R.; Zimmerman, P. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). Phys. Rev. Lett. 35: No. 12, 766-770 (22 Sept 1975).

We report results from a measurement of the inclusive process $p+d \to X+d$ in the region $0.03 < |t| < 0.12$ (GeV/c)² and 5 GeV² $< M_x^2 \lesssim 0.11 p_{lab}$ for incident proton momenta from 150 to 400 GeV/c. We find that in this region, the differential cross section $d^2\sigma/dt\, dM_x^2$ varies only slowly with energy, falls exponentially with $|t|$, and behaves to a good approximation as $1/M_x^2$. The measurement was performed at Fermilab by detecting slow-recoil deuterons from a deuterium-gas-jet target placed at the internal beam of the accelerator. (auth)

4129 OBSERVATION OF A DIFFERENCE BETWEEN POLARIZATION AND ANALYZING POWER IN Λ^0 PRODUCTION WITH 6-GeV/c POLARIZED PROTONS. Lesnik, A.; Schwartz, D.M. (Ohio State University, Columbus, Ohio 43210); Ambats, I.; Hayes, E.; Meyer, W.T.; Ward, C.E.W.; Knasel, T.M.; Swallow, E.G.; Winston, R.; Romanowski, T.A. Phys. Rev. Lett. 35: No. 12, 770-772 (22 Sept 1975).

We have measured the polarization, analyzing power, and depolarization parameter for forward Λ^0's produced with a 6-GeV/c polarized-proton beam at the Argonne National Laboratory zero-gradient synchrotron. We collected a sample of 15 281 Λ^0 production events with subsequent $p\pi^-$ decays. There is a clear difference between the polarization and analyzing power for events with Feynman scaling variable x greater than 0.8. This is the first observation of this phenomenon at high energy. (auth)

4130 STUDY OF DIFFRACTION DISSOCIATION IN 19- AND 28-GeV/c pd INTERACTIONS. Hanlon, J.; Panvini, R.; Waters, J.; Webster, M. (Vanderbilt University, Nashville, Tennessee 37235); Morris, T.W. Phys. Rev. D 12: No. 3, 673-680 (1 Aug 1975).

The reaction $pd \to p_{spec} p\pi^- p$ is studied at 19 and 28 GeV/c with data from the Brookhaven National Laboratory 80-in. deuterium-filled bubble chamber. In addition, a separate study is made of the low-momentum pion spectra in selected low-multiplicity events presumed to be associated with either of two isospin-conjugate modes of deuteron fragmentation by a 28-GeV/c beam proton. Our results from these complementary studies are that low-multiplicity channels are dominantly of a diffractive nature; however, significant differences seen in the mass spectra and angular correlations in the slow $p\pi^-$ between the 19- and 28-GeV/c data indicate that asymptotic behavior has not been reached, as least at 19 GeV/c. Neither s- nor t-channel helicity conservation is seen in the excitation of the target neutron into a low-mass $p\pi^-$ system. The N^* (1.4) of missing-mass experiments is shown to be a superposition of nucleon-pion and nucleon–two-pion states. (auth)

4131 TOPOLOGICAL CROSS SECTIONS AND PION MULTIPLICITY ANALYSIS FOR $\bar{p}p$ ANNIHILATIONS NEAR 1 GeV/c. Burns, R.R.; Condon, P.E.; Donahue, J.; Mandelkern, M.A.; Price, L.R.; Schultz, J.; Smith, D.W. (Department of Physics, University of California, Irvine, California 92664). Phys. Rev. D 12: No. 3, 638-643 (1 Aug 1975).

Topological cross sections are reported for $\bar{p}p$ annihilations with 0 to 8 prongs in the region from 0.7 to 1.1 GeV/c. After correction for nonpionic final states the moments of the neutral and charged pion multiplicity distributions are determined at an intermediate hitting in this region. We find $\langle n_- \rangle = 1.67 \pm 0.06$, $\langle n_0 \rangle = 1.77 \pm 0.13$, and correlation coefficients $f_{2^{--}} = -1.29 \pm 0.12$, $f_{2^{0-}} = -0.30 \pm 0.08$. Comparisons are made between these and other experimental results as well as several theoretical models. (auth)

Strong (Meson-induced)

4132 (CONF-750858-2) SEARCHES FOR CHARMED PARTICLES USING BUBBLE CHAMBERS. Harris, R. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). Oct 1975. 5p. Dep. NTIS $4.50.

From meeting of the ASP division of particles and fields; Seattle, Washington, USA (27 Aug 1975).

Searches for charm particle production using bubble chambers are summarized. These searches depend on the detection of neutral strange particles. Upper limits are given for the different charmed mass regions and methods of search. (auth)

4133 (DESY-75/31) TEST OF THE ZWEIG SELECTION RULE IN PHI PRODUCTION BY pp COLLISIONS. Blobel, V.; Fesefeldt, H.; Franz, H.; Hofmann, A.; Jetter, C.; Neumann, H.; Schroeder, B.; Soeding, P. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (F.R. Germany)). Aug 1975. 9p. Dep. NTIS (US Sales Only) $4.00.

Phi production is studied in pp collisions at 24 GeV/c and compared with ρ^0, ω and K^* production. The relative suppression of the Φ is in qualitative accord with its coupling to nonstrange states. No tendency is observed for the final states to contain strange particles in conjunction with the Φ. (auth)

4134 EXPERIMENTAL STUDY OF K/sub L/^0p CHARGE EXCHANGE SCATTERING AT SMALL/t/ FROM 550 TO 1000 MeV/c. Shick, M. O. Pittsburgh; Carnegie-Mellon Univ. (1975). 119p. University Microfilms Order No. 75-12,504.

Thesis (Ph. D.).

The charge exchange process, K/sub L/^0p yields K^+n, was studied in the momentum range 550 to 1000 MeV/c and for 0.03 less than parallel t parallel less than .22 $(GeV/c)^2$ using a magnetic spectrometer on line to a computer. Previously this process had been studied through the time reversed reaction in deuterium, $K^+n(p)$ yields $K^0p(p)$; where the Pauli principle suppresses the small parallel t parallel cross sections. This experiment is free of such an effect and yet the results agree in every respect with the results of deuterium studies at similar momenta. The differential cross sections are flat in t with the suggestion of a turnover in the forward direction. This behavior is characteristic of a significant component of spin flip scattering in the forward direction. (Diss. Abstr. Int., B)

4135 LOW ENERGY K^+-d INTERACTIONS. Trevvett, D. E. College Park, MD; Univ. of Maryland (1974). 164p. University Microfilms Order No. 75-17,911.

Thesis (Ph. D.).

A bubble chamber experiment was performed in order to study K^+-d interactions below 600 MeV/c; the reaction $K^+ + d$ yields $K^+ + d$ (elastic) and $K^+ + d$ yields $K^+ + p + n$ (breakup) were examined at incident K^+ momenta of 342 MeV/c and 470 MeV/c. From the 16,000 photographs examined about 2000 on-beam two-prong K-scatters were found at each momentum. For most of the elastic scatter candidates, the breakup hypothesis could not be specifically excluded; thus it was necessary to consider the possibility of breakup contamination in the elastic sample. A 2 percent confidence level cut was imposed on the elastic sample to improve the separation of events into these two categories; p-n angle and relative momentum distributions were studied to estimate the remaining contamination. Differential cross sections were obtained for both reactions; azimuthal symmetry was used to correct them for certain losses. A phase shift analysis was performed on the elastic distribution in an attempt to extract the I equals 0 K^+ - N phase shifts; a single scattering impulse approximation with a moving nucleon target was used to connect these to the observed scattering. S and P waves were sufficient to give excellent fits to the data at both momenta, as long as an anomalous "bump" in the backward region of the K scattering angle distribution (assumed to be a statistical fluctuation) was omitted from the analysis. The values obtained for these phase shifts were, however, much larger than those found in the analyses of previous experiments. The differences are examined and judged to be probably reconcilable, even within the context of the single scattering model. (Diss. Abstr. Int., B)

4136 SEARCH FOR NARROW NEUTRAL-MESON RESONANCES NEAR MASS 1 GeV/c^2. Buttram, M.; Crawley, H.B.; Duke, D.W.; Lamb, R.C.; Leeper, R.J.; Peterson, F.C. (Ames Laboratory—ERDA and Department of Physics, Iowa State University, Ames, Iowa 50010). Phys. Rev. Lett. 35: No. 14, 970-973 (6 Oct 1975).

We examine the reaction $\pi^- p \to X^0 n$ at 2.4 GeV/c for evidence of the production of the previously reported narrow neutral mesons $M^0(940)$, δ (963), $M^0(1033)$, and $M^0(1150)$. Strong evidence against the existence of these states is presented. (auth)

4137 EVIDENCE FOR A NEW MESON RESONANCE AT 2340 MeV. Baltay, C.; Cautis, C.V.; Cohen, D.; Kalelkar, M.; Pisello, D. (Columbia University, New York, New York 10027); Smith, W.D.; Yeh, N. Phys. Rev. Lett. 35: No. 14, 891-894 (6 Oct 1975).

Evidence is presented for a new meson resonance at 2340±20 MeV, with a width of 180±60 MeV, decaying primarily into $p\bar{p}\pi$. The resonance, which is observed in 15-GeV/c $\pi^+ p$ interactions, has isotopic spin 1 or 2 and odd G parity. The cross section for production of the $p\bar{p}\pi$ state is 7.3±1.7 μb. Branching ratios into $p\bar{p}\pi$ and other decay modes are given. (auth)

4138 $\pi^-\pi^+ \to \pi^-\pi^+$ INTERACTIONS BELOW 0.7 GeV FROM $\pi^- p \to \pi^-\pi^+ n$ DATA AT 5 GeV/c. Srinivasan, V.; Helland, J.A.; Lennox, A.J.; Poirier, J.A.; Prukop, J.P.; Rey, C.A.; Sander, O.R.; Cason, N.M.; Kenney, V.P.; Biswas, N.N.; Shephard, W.D. (Department of Physics, University of Notre Dame, Notre Dame, Indiana 46556); Klem, R.D.; Spirn, I. Phys. Rev. D 12: No. 3, 681-692 (1 Aug 1975).

Magnetostrictive spark chambers were used with a large-aperture magnet spectrometer to study the reaction $\pi^- p \to \pi^-\pi^+ n$ at 5.0 GeV/c at Argonne National Laboratory. Differential cross sections for this reaction were measured in the region of low nucleon momentum transfer. Extrapolation techniques were used to obtain cross sections and phase shifts for the reaction $\pi^-\pi^+ \to \pi^-\pi^+$ in the region of dipion mass less than 0.7 GeV. Effects of the interference between the strong $\pi^-\pi^+$ amplitude and the Coulomb amplitude off the mass shell were investigated and were found to be small. (auth)

4139 STUDY OF VECTOR MESON + BARYON RESONANCE PRODUCTION IN $\pi^+ p$ INTERACTIONS AT 7.1 GeV/c. Chung, S.U.; Protopopescu, S.D. (Brookhaven National Laboratory, Upton, New York 11973); Eisner, R.L.; Flatté, S.M. Phys. Rev. D 12: No. 3, 693-718 (1 Aug 1975).

From a large-statistics $\pi^+ p$ experiment at 7.1 GeV/c, data are presented on the reactions $\pi^+ p \to \rho^0 \Delta^{++}(1238)$ and $\pi^+ p \to g\omega\Delta^{++}$ (1238). Cross sections, differential cross sections, and vector-meson single-density-matrix elements are presented and a general comparison of the production properties of the two reactions is given. In addition to (ρ,ω) $\Delta^{++}(1238)$ production there is also strong evidence for production of a $\pi^+ p$ enhancement with mass ~1880 MeV, $\Gamma \sim 200$ MeV, and $J \geq 7/2$ produced in association with the ρ and ω resonances. Detailed properties of this structure are presented and its production mechanism is compared with that of the corresponding Δ (1238) reactions. This state is also observed in the reaction $K^+ p \to K^{*0}(890)\,\Delta^{++}(1880)$ at 12.0 GeV/c, for which data are also presented. (auth)

4140 INVERSE PION PHOTOPRODUCTION IN THE VICINITY OF THE $P_{33}(1232)$ RESONANCE AND A TEST OF TIME-REVERSAL INVARIANCE. Comiso, J.C.; Blasberg, D.J.; Haddock, R.P.; Nefkens, B.M.K.; Truoel, P.; Verhey, L.J. (Physics Department, University of California, Los Angeles, California 90024). Phys. Rev. D 12: No. 3, 719-737 (1 Aug 1975).

Differential cross-section measurements are presented for $\pi^- p \to \gamma n$ at five energies around the $P_{33}(1232)$ resonance. A detailed comparison is made with $\gamma n \to \pi^- p$ deduced from γd experiments. In general, the results are in support of detailed balance. Using the Christ-Lee–Donnachie-Shaw model, our new data indicate that the T-violating phase in the isovector part of the M_{1+} multipole is less than 2°, which is a very sensitive test of time-reversal invariance. No evidence is found for a possible isotensor component of the electromagnetic current. Our data are compared to various multipole analyses. In general, the agreement is poor. (auth)

4141 DIFFERENTIAL CROSS-SECTION MEASUREMENTS OF $\pi^- p \to \pi^0 n$ AROUND THE $P_{33}(1232)$ RESONANCE. Comiso, J.C.; Blasberg, D.J. ; Haddock, R.P.; Nefkens, B.M.K.; Truoel, P.; Verhey, L.J. (Physics Department, University of California, Los Angeles, California 90024). Phys. Rev. D 12: No. 3, 738-743 (1 Aug 1975).

Differential cross section for $\pi^- p \to \pi^0 n$ at five angles for 239, 264, 295, 323, and 375 MeV/c incident pions are presented. The measurements employ the neutron-photon coincidence method, using carefully calibrated neutron counters and an efficient, large-area photon detector. Good agreement is found with the results of the CERN phase-shift analysis. (auth)

4142 $\bar{K}K$ SYSTEM IN $\pi^- p \to K^- K^+ n$ AT 6 GeV/c. Pawlicki, A.J.; Ayres, D.S.; Diebold, R.; Greene, A.F.; Kramer, S.L.; Wicklund, A.B. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. D 12: No. 3, 631-637 (1 Aug 1975).

The reaction $\pi^- p \to K^- K^+ n$ has been studied at 6 GeV/c with a 16 000 event data sample obtained with the Argonne National Laboratory Effective Mass Spectrometer. Moments of the $K^- K^+$ decay angular distributions are shown as functions of the $K^- K^+$ effective mass from threshold to 1500 MeV, and as functions of momentum transfer from t_{min} to −0.4 GeV². The t-channel moments $\langle Y_l^m \rangle$ with $m=0$ dominate over the $m=1$ moments, while moments with $m \geq 2$ (and those with $l \geq 6$) are negligible; this indicates that the dominant t-channel exchange production amplitudes have helicity zero at the meson vertex. The slope of $d\sigma/dt$ decreases as the $K^- K^+$ mass increases. There is a broad D-wave enhancement near 1350 MeV. Interfering f and A_2^0 D-wave Breit-Wigner resonances are not sufficient to explain all of the Y_4^0 distribution above 1350 MeV and an additional D-wave contribution may be present. Ignoring this complication, the best f-A_2^0 fit to the Y_4^0 spectrum yields a branching ratio $(f \to \bar{K}K)/(f \to \text{all}) = (3.1 \pm 1.0)$ %. (auth)

4143 MEASUREMENT OF THE POLARIZATION PARAMETER P IN ELASTIC $\pi^+ p$ SCATTERING AT 450 MeV. Bekrenev, V.S.; Gaditskiĭ, V.G.; Gordeev, V.A.; Kashchuk, A.P.; Kruglov, S.P.; Kuz'min, L.A.; Kulbardis, A.A.; Lopatin, I.V.; Maksev, T.G.; Suvorova, L.V.; Sumachev, V.V.; Tkach, I.I.; Filimonov, E.A.; Shchegel'skiĭ, V.A.; Shcherbakov, V. (Leningrad Institute of Nuclear Physics). JETP Lett. 21: No. 10, 282-283 (20 May 1975).

The polarization parameter in elastic πp scattering was measured in a wide range of angles at 450 MeV both for negative and positive ions. The results are compared with the data obtained from various phase-shift analyses, and are also discussed from the point of view of isospin invariance. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 3726, 4466, and 4593.

4144 (CNRS-CPT-74/P634) RENORMALIZATION OF THE ABELIAN HIGGS–KIBBLE MODEL. Becchi, C.; Rouet, A.; Stora, R. (Centre National de la Recherche Scientifique, 13 - Marseille (France). Centre de Physique Theorique). Jul 1974. 54p. Dep. NTIS (US Sales Only) $5.50.

The renormalization of the abelian Higgs–Kibble model, is the simplest model involving gauge fields in which no infrared problem occurs. Use is made of the combinatorial knowledge of renormalized perturbation theory and also the implicit function theorem for formal power series. (JFP)

4145 (COO-2271-61) THEORETICAL HIGH ENERGY PHYSICS. Renewal Proposal and Research Report, October 1, 1975–September 30, 1976. Lee, T. D.; Serber, R. (Columbia Univ., New York (USA)).. May 1975. Contract AT(11-1)-2271. 27p. Dep. NTIS $5.00.

Research on nuclear, atomic, and high energy physics is summarized. A list of publications is included. (JFP)

4146 (FERMILAB-Conf-75/63) AGENDA FOR CORRELATIONS. Quigg, C. (Fermi National Accelerator Lab., Batavia, Ill. (USA); European Organization for Nuclear Research, Geneva (Switzerland)). Aug 1975. 9p. (CONF-750742-1). Dep. NTIS $4.00.

From 6th international colloquium on multiparticle dynamics; Oxford, UK (Jul 1975).

A brief discursive summary of the structure of events; and for particle interactions some unanswered questions are presented. (auth)

4147 (IC-75/77) SMALL OSCILLATIONS OF THE RELATIVISTIC BAG. Rebbi, C. (International Centre for Theoretical Physics, Trieste (Italy)). Jul 1975. 19p. (CONF-750479-2). Dep. NTIS (US Sales Only) $4.00.

From workshop on theoretical physics; Erice, Italy (30 Apr 1975).

The dynamics of the MIT bag model is studied in the limit of small oscillations about a static spherical configuration. A Hamiltonian formalism is developed to describe these small oscillations and to perform an approximate quantization of the system. (auth)

4148 (JINR-E2-9151) SOME REMARKS ON PRODUCTION PROCESSES. Mihul, E. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 14p. Dep. NTIS (US Sales Only) $4.50.

The strong shrinkage increasing with the energy of the Δ histogram is obtained $\Delta = \det \{p_i^k\}_{i=1,2,3,4;\ k=0,1,2,3}$ where p_1, p_2, p_3, p_4 are 4-momenta of the final particles of the reaction $a + b \to a_1 + a_2 + a_3 + a_4$. The suggestion of other interesting possible experimental objects of testing is indicated. It is stipulated that the dimensionality of the space generated by n 4-momenta of the n produced particles for $n \geq 4$ at high energy is less than 4. (auth)

4149 (KFKI-75-43) STATISTICS AND INTERNAL QUANTUM NUMBERS IN THE STATISTICAL BOOTSTRAP APPROACH. Montvay, I. (Kozponti Fizikai Kutato Intezet, Budapest (Hungary)). 1975. 37p. (CONF-750479-1). Dep. NTIS (US Sales Only) $5.00.

From workshop on theoretical physics; Erice, Italy (30 Apr 1975).

After a short review of the statistical bootstrap equations without quantum numbers the recent developments in the quantum number problem are discussed. First the full bootstrap is considered in the case of a general internal symmetry group. The Fourier transformation on the group is used to solve the bootstrap equation with quantum numbers /including exotic states/. Another approach based on the Chan-Paton factor of the dual resonance model gives the possibility of excluding exotic states. The general case of the linear chain bootstrap with quantum numbers is considered. It is shown that a complete and simple solution can be obtained assuming that fireball states are characterized by products of quark quantum numbers and inside the fireball the quarks are emitting resonances independently of each other. The general bootstrap equation is also considered in the quark model. The problem of Bose- and Fermi- statistics is first discussed in the case of ideal relativistic quantum gas. It turns out that quantum corrections are important in particle physics situations and manifest themselves as a clustering effect among particles. The question of introducing quantum statistics in the statistical bootstrap equation is considered in a dynamical context. (auth)

4150 (LBL-4237) COLOR AND EXPERIMENTAL PHYSICS. Chanowitz, M. S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 20 Aug 1975. Contract W-7405-ENG-48. 32p. (CONF-750858-7). Dep. NTIS $4.75.

From meeting of the ASP division of particles and fields; Seattle, Washington, USA (27 Aug 1975).

After a brief review of the color hypothesis and the motivations for its introduction, the experimental tests are discussed. It is assumed that colored states have not been produced at present energies and only experimental tests which apply below the color threshold, when color is a "hidden symmetry," are discussed. Some of these tests offer the possibility of distinguishing between quark models with fractional and integral quark charges. (auth)

4151 THE ADLER SELF-CONSISTENCY CONDITION IN THE DECAY $\psi'(3700) \to \psi(3100)\pi\pi$. Voloshin, M.B. (Moscow Physico-technical Institute). JETP Lett. 21: No. 12, 347-348 (20 June 1975).

The distribution with respect to the invariant mass of two pions in the $\psi' \to \psi\pi\pi$ decay is calculated by using the Alder self-consistency condition. (auth)

4152 RESTRICTION ON THE PERPENDICULAR MOMENTA IN THE PRODUCTION OF VECTOR PARTICLES IN RENORMALIZABLE YANG-MILLS MODELS. Frankfurt, L.L.; Sherman, V.E. (Leningrad Institute of Nuclear Physics, USSR Academy of Sciences). JETP Lett. 21: No. 12, 348-349 (20 June 1975).

It is shown that the main contribution to the cross section for the production of vector particles in collisions of high-energy fermions is made in renormalizable models of the Yang–Mills type by perpendicular momenta of the same order as the mass. (auth)

4153 REMARKS ON THE RELATIVISTIC QUANTUM GAS WITH INTERACTION AND COMPARISON WITH THE BOOTSTRAP HYPOTHESIS. Fre, P.; Sertorio, L. (Univ., Turin). Nuovo Cim., A; 28A: No. 4, 538-562(21 Aug 1975).

One discusses some consequences of the Bernstein, Dashen and Ma formalism of statistical mechanics, concerning the definition of the mass spectrum and the level density for interacting gas. A recipe for constructing the relativistic level density of N interacting quantum particles is provided. Comparison with the bootstrap equation leads to a dynamical interpretation of the Yellin coefficients. (auth)

4154 ONE-LOOP AMPLITUDE IN THE DUAL MODEL OF VIRASORO–SHAPIRO. Laperashvili, L. V.; Samsonidze, G. G. (Inst. of Physics, Tbilisi, USSR). Yadern. Fiz.; 22: No. 2, 373-381(Aug 1975). (In Russian)

The one-loop amplitude of N particle interaction in the dual V. S. model is built using the interaction of closed relativistic strings. The asymptotic behavior of the four-tail diagram when the total energy goes to infinity is studied. It is shown that the asymptotics of the scattering amplitude is determined by a two-pomeron Regge branching point. In contrast to the Veneziano model, there arise no additional singularities in the V.S. model. (2 figures) (auth)

4155 IMPACT PARAMETER DYNAMICS IN QUANTUM THEORY AT LARGE ANGLE SCATTERING. Andrianov, A. A. (Leningrad State Univ.). Yadern. Fiz.; 22: No. 2, 385-400(Aug 1975). (In Russian)

High energy behavior of a free particle Green's function is studied for construction of the scattering amplitude. The main part of the Green's function is determined by eikonal scattering along the mean momentum and by the total scattering along the transferred momentum. This impact approximation may be included as a first approximation in the iteration scheme for the scattering amplitude along the mean momentum, i.e. the impact perturbation theory. With the help of the impact approximation an expansion of the scattering amplitude in the impact parameter depending on interaction is obtained. These expansions are more correct than the eikonal expansions at large angle scattering. The results are illustrated graphically for the exponential and the Yukawa potentials. (2 figures) (auth)

4156 AVERAGE MULTIPLICITY AND THE ZEROS OF MULTIPARTICLE GENERATING FUNCTION. Kinoshita T. (Cornell Univ., Ithaca, NY); Maharana, J. J. Math. Phys. (N. Y.); 16: No. 11, 2294-2300(Nov 1975).

Several theorems exhibiting relations between the asymptotic behavior of the average multiplicity (n) and the distribution of zeros of a generating function for multiparticle production cross sections are obtained. (auth)

4157 TWO-COMPONENT MODEL FOR DEEP INELASTIC LEPTON-NUCLEON SCATTERING. Argyres, E.N. (Department of Physics, College of Arts and Science, State University of New York, Plattsburgh, New York 12901); Lam, C.S. Phys. Rev. Lett. 35: No. 14, 894-898 (6 Oct 1975).

A two-component model of deep inelastic lepton-nucleon scattering is presented in which the phenomena that the usual quark-parton model attributes to the presence of the core (wee) quarks are instead described by a generalized vector-meson-dominance model, modified to take into account a correction arising from the finite size of the nucleon and the uncertainty principle. The model predicts the core-quark distribution in satisfactory agreement with the results of neutrino experiments. (auth)

4158 PHENOMENOLOGY OF GOLDSTONE NEUTRINOS. de Wit, B.; Freedman, D.Z. (Institute for Theoretical Physics, State

University of New York at Stony Brook, Stony Brook, New York 11794). Phys. Rev. Lett. 35: No. 13, 827-830 (29 Sept 1975).

The hypothesis that the physical neutrino is a Goldstone particle associated with spontaneously broken supersymmetry is studied with emphasis on the ensuing low-energy theorems. A picture of low-energy neutrino phenomenology is found which is attractive for neutral-current processes, but is in strong disagreement with experimental end-of-lepton-spectrum behavior in β decays. (auth)

4159 RELATIVISTIC EFFECTS IN BOUND-STATE FORM FACTORS. Woloshyn, R.M. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). Phys. Rev. C 12: No. 3, 901-908 (Sept 1975).

The formalism for bound-state form factors in a three-dimensional relativistic theory is used to expose the theoretical limitations of recent work on meson exchange currents. The pair excitation and recoil emission currents used in phenomenological calculations are found to have little theoretical support. The constraints imposed by the Ward identity are examined and the singularity structure of the form factor in relativistic and nonrelativistic theories is compared. (auth)

4160 THREE-PARTICLE REGGE POLE ϕ^3 THEORY. McCoy, B.M. (Institute for Theoretical Physics, State University of New York, Stony Brook, New York 11794); Wu, T.T. Phys. Rev. D 12: No. 2, 578-580 (15 July 1975).

We prove that the location $-2 + \alpha_3(\vec{\Delta})$ of the three-particle Regge pole in ϕ^3 theory obeys $\alpha_3(0) > 2.229271492\,4\alpha\,(0)$, where $-2 + \alpha\,(0)$ is the position of the Reggeon-particle cut. (auth)

4161 MANDELSTAM DIAGRAMS ARE NOT ENOUGH TO STUDY THE HIGH-ENERGY BEHAVIOR OF ϕ^3 THEORY. McCoy, B.M. (Institute for Theoretical Physics, State University of New York, Stony Brook, New York 11794); Wu, T.T. Phys. Rev. D 12: No. 2, 546-577 (15 July 1975).

Viewed in the crossed channel, the ϕ^3 Mandelstam diagrams for the Reggeon-particle cut represent repeated interaction between two of the three exchanged particles. A much larger class of Feynman diagrams is obtained by allowing all three exchanged particles to participate in the interaction, as required by Bose statistics. It is found that, in the limit of high energies, all diagrams of the same order in this larger class contribute comparably. In particular, the contributions from the Mandelstam and non-Mandelstam diagrams are of the same order of magnitude. This larger class of diagrams is summed in terms of an integral equation. It is found from this integral equation that if the momentum transfer is not too large, then the leading singularity in the angular momentum plane is a pole. As the momentum transfer increases this pole eventually disappears into a cut. These considerations are generalized, in a nontrivial way, to the case of the Reggeon-Reggeon cut. The signature factor plays a most important role, and some of the contributing diagrams show unexpected high-energy behavior. The profound effect of these additional diagrams on the program of Reggeon calculus is discussed. (auth)

4162 STRING APPROACHES TO HADRON STRUCTURE. Frampton, P.H. (Department of Physics, Syracuse University, Syracuse, New York 13210). Phys. Rev. D 12: No. 2, 538-545 (15 July 1975).

The two principal string approaches to a more realistic dual resonance model are discussed. Firstly, Nambu's proposal of 1974, identifying the Dirac magnetic-monopole string with the dual string, after spontaneous breakdown and the Higgs mechanism in a strong-coupling limit, is investigated. The mathematics underlying Nambu's rather intuitive derivation has been further investigated by Balachandran, Rupertsberger, and Schechter (who put in the vector mass by hand) and independently by Jevicki and Senjanović (who fully exploit spontaneous breaking and the Higgs mechanism). Here we show that in a leading approximation to the Nambu monopole action the phenomenologically desirable linearity of the leading Regge trajectory seems to be badly violated. Secondly, alternative quantization procedures for the original 1970 Nambu relativistic string action (area of the world sheet) are treated; in particular, a timelike identification of the string time τ which has recently been advocated by Patrascioiu, by Rohrlich, and by Goddard, Hanson, and Ponzano. The most novel of these discussions seems to be that of Rohrlich, who uses a quite different representation for the canonical algebra and the Poincaré group. Here we demonstrate, however, that the usual unphysical level spectrum with a massless first excited state emerges as a fully consistent solution even in this approach, and that probably no other solution exists. Finally, the various Nambu string approaches are compared to other attempts to discover the "right" model of strong interactions. (auth)

4163 SCALAR BINDING OF QUARKS. Critchfield, C.L. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). Phys. Rev. D 12: No. 3, 923-925 (1 Aug 1975).

A scalar potential which is linear in the radius is used to confine relativistic individual quark states. Calculation results are compared with those of the "bag" model. (auth)

4164 ELECTRIC DIPOLE AND QUADRUPOLE POLARIZABILITIES OF HADRONS. Schröder, U.E. (Institut für Theoretische Physik der Universität Frankfurt/Main, Frankfurt/Main, Germany). Phys. Rev. D 12: No. 3, 896-901 (1 Aug 1975).

A method for determining the electric multipole polarizabilities of the proton is presented. In particular, the following theoretical values for the electric dipole and quadrupole polarizabilities of the proton are obtained: $\kappa_{E1} \simeq 0.75\times10^{-3}$ fm^3 and $\kappa_{E2} \simeq -0.7\times10^{-3}$ fm^5. This results in the static approximation from the inelastic contribution of the two-photon exchange process to the scattering of a scalar charged particle by the proton. (auth)

4165 HYDRODYNAMICAL EXPANSION WITH FRAME-INDEPENDENCE SYMMETRY IN HIGH-ENERGY MULTIPARTICLE PRODUCTION. Chiu, C.B.; Sudarshan, E.C.G.; Wang, K. (The Center for Particle Theory, Department of Physics, University of Texas, Austin, Texas, 78712). Phys. Rev. D 12: No. 3, 902-908 (1 Aug 1975).

We describe the space-time development of the hadronic system formed immediately after the high-energy hadron collision with the following picture. Initially the system is highly compressed along the longitudinal direction. The sudden relaxation of this compression leads to a violent acceleration along this direction and perhaps a weak acceleration along the transverse direction. When these accelerations cease, we propose that the system acquires certain frame-independence symmetry with its further expansion governed by the hydrodynamic equation of motion. Within our scheme, this symmetry provides a natural mechanism which eventually leads to a flat inclusive longitudinal rapidity distribution and it also admits a sharp cutoff in the inclusive transverse momentum distribution. These features differ from those of Landau's model. (auth)

4166 ENERGY SCALES AND DIFFRACTION SCATTERING. Dash, J.W. (Institute of Theoretical Science, Department of Physics, University of Oregon, Eugene, Oregon 97403); Koplik, J. Phys. Rev. D 12: No. 3, 785-791 (1 Aug 1975).

The influence of thresholds on models of diffraction scattering is considered. We use the experimental existence of effective inelastic diffraction and baryon-antibaryon thresholds to conjecture a relationship between the bare Pomeron P^0, of the Gribov calculus, the bare Pomeron P^E of recent fits to Fermilab–CERN-ISR elastic data, and a bare Pomeron $\hat{P}$ of intercept $\hat{\alpha}_0 \simeq 0.85$ utilized in medium-energy two-body and high-energy inclusive phenomenology. A set of energy scales is set up describing approximate regions of validity of various models for diffraction, including the Gribov calculus. An iterative approximation scheme to the s- and t-channel unitarity equations at small t and large s is described. (auth)

4167 EXACT SPECTRAL-FUNCTION SUM RULES. Bernard, C. (Lyman Laboratory of Physics, Harvard University, Cambridge, Massachusetts 02138); Duncan, A.; LoSecco, J.; Weinberg, S. Phys. Rev. D 12: No. 3, 792-804 (1 Aug 1975).

A general procedure for extracting exact spectral-function sum rules is presented. The short-distance behavior of products of vector and axial-vector currents is related to the convergence (or superconvergence) of the original first and second spectral sum rules together with a third sum rule involving only the spin-0 spectral function. The operator-product expansion is then applied to determine all (and only) those linear combinations of current propagators for which the short-distance behavior is sufficiently soft to yield superconvergent sum rules for the corresponding combinations of spectral functions. Our method is applied to determine the complete set of sum rules for a theory defined by a global chiral SU(4) $\times$SU(4) symmetry, broken (a) explicitly by hadron (quark) masses and (b) by dynamical symmetry breaking to any subgroup containing the symmetry group of the mass matrix. Our derivation is strictly true only for asymptotically free theories, but the results are expected to apply for a range of other theories. The method is easily extended to deal with current propagators involving scalar and pseudoscalar densities (*not* necessarily divergences of vector or axial-vector currents) —the relevant sum rules in the context of the SU(4) $\times$SU(4) model are derived. Finally, we compare our approach and results to those of several recent studies of the spectral-function sum rules. An appendix presents a proof that Wilson functions exhibit the full symmetries of any theory, whether or not these are spontaneously broken. (auth)

4168 COLOR MODEL FOR THE ψ'S. Bars, I.; Peccei, R.D. (Institute of Theoretical Physics, Department of Physics, Stanford University, Stanford, California 94305). Phys. Rev. D 12: No. 3, 823-833 (1 Aug 1975).

We elaborate on an earlier suggestion that the recently discovered ψ particles are "colored" vector mesons. We discuss in detail the production of these states by photons and hadrons and their possible decay modes. Constraints on the spectroscopy of these new color states are examined and crucial experimental tests for the model are outlined. (auth)

4169 LOCAL QUANTUM-NUMBER COMPENSATION IN MULTIPLE PRODUCTION. Quigg, C. (Fermi National Accelerator

Laboratory, Batavia, Illinois 60510). Phys. Rev. D 12: No. 3, 834-840 (1 Aug 1975).

Experimental distributions are defined which are sensitive to the existence and nature of short-range phenomena. Clustering of produced hadrons is established directly. The possibility that clusters responsible for strange particle or baryon production differ from those responsible for pion production is entertained. Similarities and distinctions between transverse momentum and other additive quantum numbers are discussed. (auth)

4170 DYNAMICS OF LIGHT AND HEAVY BOUND QUARKS. Kang, J.S.; Schnitzer, H.J. (Department of Physics, Brandeis University, Waltham, Massachusetts 02154). Phys. Rev. D 12: No. 3, 841-854 (1 Aug 1975).

A simple relativistic potential model is constructed in order to describe meson spectroscopy in a unified way, encompassing both light- and heavy-quark systems. A linear potential, transforming as the fourth component of a vector potential, is assumed in accordance with quark-confinement mechanisms appropriate to gauge theories. Scaling arguments are used to derive the Regge behavior of the model. We present evidence that the forces which confine quarks are essentially independent of quark species. The over-all systematics of our predictions for meson energy levels and leptonic decay widths give support to the usefulness of the model. We comment on the application of asymptotic freedom as a means of estimating decay rates which violate the Okubo-Zweig-Iizuka rule. (auth)

4171 BOOTSTRAP MODEL WITH A BARE POMERON. Yaes, R.J. (Department of Physics, Memorial University of Newfoundland, St. John's, Newfoundland, Canada, A1C5S7). Phys. Rev. D 12: No. 3, 805-817 (1 Aug 1975).

We use the resolvent-kernel technique to obtain the inclusive distributions in a one-dimensional bootstrap model containing both pionization and diffraction. In the case where diffraction is described by a bare Pomeron with intercept less than one, we obtain an exact solution of the bootstrap equation for the single-particle distribution, which can display correct double-Regge behavior near $x=0$. For a Pomeron with intercept exactly one, we obtain a multifireball expansion for the inclusive distribution in powers of the Pomeron coupling constant. Comparison of the multifireball expansion for the bare Pomeron, with the exact solution, indicates that the expansion does not correctly describe the distribution near $x=0$. We discuss the solution of the n trajectory, one-dimensional bootstrap model and its relation to conventional treatments of the n-trajectory Chew-Pignotti model. (auth)

4172 EXACT CLASSICAL SOLUTION FOR THE 't HOOFT MONOPOLE AND THE JULIA-ZEE DYON. Prasad, M.K.; Sommerfield, C.M. (Sloane Physics Laboratory, Yale University, New Haven, Connecticut 06520). Phys. Rev. Lett. 35: No. 12, 760-762 (22 Sept 1975).

We present an exact solution to the nonlinear field equations which describe a classical excitation possessing magnetic and electric charge. This solution has finite energy and exhibits explicitly those properties which have previously been found by numerical analysis. (auth)

4173 ARE THE ψ AND ψ' MESONS ORBITAL EXCITATIONS OF ω AND ϕ? Khrushchev, V.V. (Institute of High-Energy Physics). JETP Lett. 21: No. 10, 290-291 (20 May 1975).

On the basis of the SU(6) $\times$O(3) quark model, the vector mesons ψ (3105) and ψ' (3695) are interpreted as orbital excitations of ω and ϕ. New mesons $\tilde{\rho}$ (3100) ($\Gamma_{\tilde{\rho}}<\Gamma_\rho$) and K (3400), ($\Gamma_{\tilde{K}}<\Gamma_{K^*}$) are predicted; they are members of the SU(3) nonet with $J^{PC}=1^{--}$ and $L=2$. (auth)

4174 COHERENT MODEL OF ψ BOSONS. Shapiro, I.S. (Institute of Theoretical and Experimental Physics). JETP Lett. 21: No. 10, 293-294 (20 May 1975).

The interpretation of ψ particles as a boson condensate explains the observed suppression of the amplitudes of pure pionic channels of the decay of ψ in comparison with process $\psi\to 2\pi\psi$. (auth)

Electromagnetic

4175 (CONF-720133-4, pp 73-91) UNIFIED SOLUTION TO THE $\pi^0\to 2\gamma$ AND eta $\to 3\pi$ DECAY PUZZLES. Mendes, R. V. (Junta de Energia Nuclear, Sacavem, Portugal). 1972.

From 4th symposium on theoretical physics; Rio de Janeiro, Brazil (4 Jan 1972).

In IV Brazilian symposium on theoretical physics. Volume XI.

A brief review is given of the $\pi^0\to 2\gamma$ and $\eta\to 3\pi$ puzzles in current algebra. It is shown how they find a simple solution in the framework of a model originally proposed to generate algebraic Schwinger terms in the quark model. A sum rule is derived that relates the $\pi^0\to 2\gamma$ decay width extrapolated to zero pion mass and the total e^+e^- annihilation cross sections. The sum rule is experimentally evaluated, and its predictions concerning the asymptotic behavior of $\sigma(e^+e^-\to$ hadrons) discussed. (auth)

4176 (DESY-75/23) ELECTROPRODUCTION OF NEUTRAL PIONS AT ENERGIES ABOVE THE RESONANCE REGION. Brasse, F. W.; Fehrenbach, W.; Flauger, W. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (F.R. Germany)). Jul 1975. 11p. Dep. NTIS (US Sales Only) $4.00.

The reaction $e\,p\to e'\,p\,\pi^0$ was measured at W = 2.55 GeV and a fixed electron scattering angle of 10.3°. Two magnetic spectrometers and a lead glass hodoscope were used to detect all four final state particles. Electroproduction cross sections in the t range −0.15 to −1.4 $(GeV/c)^2$ at $q^2=-0.22$, −0.55 and −0.85 $(GeV/c)^2$ are presented. Above $|t| = 0.6$ $(GeV/c)^2$ the cross sections are considerably smaller than those for photoproduction. (auth)

4177 (DESY-75/29) ELECTROPRODUCTION OF π^+ MESONS IN THE RESONANCE REGION. Alder, J. C.; Behrens, H.; Brasse, F. W.; Fehrenbach, W.; Gayler, J.; Goel, S. P.; Haidan, R.; Korbel, V.; May, J.; Merkwitz, M. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (F. R. Germany)). Aug 1975. 16p. Dep. NTIS (US Sales Only) $4.00.

Results on the reaction $ep\to e'n\pi^+$ are presented in the mass range $1.355\le W\le 1.775$ GeV at $q^2=1$ GeV^2 and in the range $1.415\le W\le 1.595$ GeV at $q^2=0.6$ GeV^2. From the angular distribution of the π^+ meson the polarization terms $\sigma_u+\epsilon\sigma_l$, σ_p and σ_l were determined in the range of production angles $0<\theta^*_{\pi^+}\lesssim 63°$. (auth)

4178 (ORO-3992-236) MAGNETIC MONOPOLES AND DISTORTED GAUGE SYMMETRY. Hsu, J. P. (Texas Univ., Austin (USA). Center for Particle Theory). Oct 1975. 10p. Dep. NTIS $4.50.

It is shown that magnetic monopoles occur in massive vector boson theory with an intrinsic symmetry breakdown while still possessing distorted gauge symmetry. The exact static spherically symmetric solutions for the monopole are obtained. Their meaning is discussed on the basis of gauge symmetry. (auth)

4179 ELECTROMAGNETIC FORM FACTOR OF THE (SCALAR) DEUTERON. Swanson, D.L. (Department of Physics, University of California, Los Angeles, California 90024). Phys. Rev. D 12: No. 4, 1138-1142 (15 Aug 1975).

The off-mass-shell behavior of the electromagnetic form factor of the composite (scalar) deuteron is examined in a simple source-theoretic model in a nonrelativistic context. In particular, an explicit low-energy reduction of the general double-spectral form shows how the elements of the particle description combine to give the usual quantum-mechanical interpretation of the form factor as the Fourier transform of a charge density with the final-state theorem being satisfied. (auth)

4180 TWO-PARTICLE DECAYS OF ψ RESONANCES AND ELECTROMAGNETIC EFFECTS. Bazhanov, V.V.; Pron'ko, G.P.; Solov'ev, L.D. (Institute of High Energy Physics). JETP Lett. 21: No. 11, 318-320 (5 June 1975).

A formula is obtained for the cross section of the processes $e^+e^-\to l^+l^-$ in the resonance region; this formula is valid in all orders in the electromagnetic interaction. Its application to ψ resonances makes it possible to determine the resonance parameters. (auth)

4181 INVARIANT AMPLITUDES FOR VIRTUAL COMPTON SCATTERING OFF POLARIZED NUCLEONS FREE FROM KINEMATICAL SINGULARITIES, ZEROS, AND CONSTRAINTS. Tarrach, R. (CERN, Geneva). Nuovo Cim.; 28A: No. 4, 409-422 (21 Aug 1975).

A complete set of independent gauge-invariant and Lorentz-covariant tensors which carry the maximal amount of kinematics and which are either even or odd under the discrete symmetries and crossing is given for virtual-photon scattering off polarized nucleons. The remaining kinematics are explicitly shown in the amplitudes. A great variety of different processes of physical interest may be described with this set by taking the adequate limits. The possible connections among these different limits are now open. (auth)

4182 ANALYSIS OF VECTOR-MESON PHOTOPRODUCTION IN TERMS OF A MULTICHANNEL IMPACT-PARAMETER FORMALISM. Drechsler, W.; Grifols, J. A. (Max-Planck Inst. fuer Physik und Astrophysik, Munich). Nuovo Cim.; 28A: No. 4, 423-443(21 Aug 1975).

An analysis of high energy data on ρ^0, ω^0, and φ^0 photoproduction on protons is carried out in the context of the multichannel impact-parameter formalism which had been successfully applied previously to Compton scattering on protons and neutrons providing a unified theoretical description for all these photon-induced diffractive processes. Particular attention was devoted to the determination of the helicity-flip structure for the asymptotically leading, i.e. Pomeranchuk, part of vector-meson photoproduction amplitudes. The proposed K-matrix description allows the existence of a helicity-flip contribution to Pomeranchuk exchange albeit with unknown coupling strength. φ^0 photoproduction is especially suited to investigate in detail the nature of the Pomeranchuk coupling in diffractive photoproduction processes since no lower-lying trajectories can contribute. The analysis lends

support to the presence of a substantial helicity-flip contribution for the nucleons in high energy vector-meson photoproduction which is to be associated with Pomeranchuk exchange. (auth)

4183 JET STRUCTURE AND SCALING IN e^+e^- ANNIHILATION. Baier, R. (Univ. of Bielefeld, Germany); Engels, J.; Satz, H.; Schilling, K. Nuovo Cim.; 28A: No. 4, 455-474 (21 Aug 1975).

An uncorrelated jet model, with randomly oriented jet axis and parameters as determined from high energy hadronic interactions, is applied to e^+e^- annihilation. The resulting features (multiplicities, spectra, correlations, branching ratios) are calculated both at finite c.m.s. energies ((3 to 5) GeV) and asymptotically, in order to study the approach to asymptotic behavior expected for quark, parton and similar models. It is shown that such descriptions, where the jet structure is the same as in hadron-hadron interactions, lead for kinematic reasons to very late scaling of the normalized inclusive hadron distribution. The results are compared with cluster models for e^+e^- annihilation and with data. (auth)

4184 APPROACH TO ASYMPTOPIA IN ELECTRON–POSITRON ANNIHILATION INTO HADRONS. Choudhury, D. K. (Daresbury Lab., Eng.). Nuovo Cim.; 28A: No. 4, 510-518 (21 Aug 1975).

Assuming CEA/SPEAR energies to be nonasymptotic, a bound on the asymptotic ratio $R_\infty = \lim_{s\to\infty} [\sigma(e^+e^- \to \text{hadrons})/\sigma(e^+e^- \to \mu^+\mu^-)]$ to be $6.69 \pm 1.0 \lesssim R_\infty \lesssim 7.77 \pm 1.0$ from the positivity of the parton mass squared. The estimate is based on the application of leading-order finite-mass correction to the light-cone algebra/parton model in the nonaymptotic region. (auth)

4185 MAGNETIC MONOPOLES AND DISTORTED GAUGE SYMMETRY. Hsu, J. P. (Univ. of Texas, Austin). Lett. Nuovo Cim.; 14: No. 6, 189-192(11 Oct 1975).

It is pointed out that magnetic monopoles exist in vector-boson theories with intrinsic symmetry breakdown rather than spontaneously broken symmetry. Also exact static spherically symmetric solutions are obtained for the magnetic monopole. Their meaning is understood in terms of the electromagnetic field on the basis of symmetry. (JFP)

4186 POLARIZATION EFFECTS IN HIGH-ENERGY VECTOR-MESON PHOTOPRODUCTION. Grifols, J. A. (Max-Planck-Inst. fuer Physik und Astrophysik, Munich). Lett. Nuovo Cim.; 14: No. 6, 197-203(11 Oct 1975).

The possible experiments with polarized beams and/or polarized targets which could directly test the indirect finding of a violation of s-channel helicity conservation for the recoiling proton in ϕ^0 and φ^0 photoproduction. Various parameters for this photoproduction of vectors mesons are presented. From these figures it is found that there are sizable polarization effects expected to be present in ϕ^0 and φ^0 photoproduction up to very high energies. (JFP)

4187 COMPTON SCATTERING BY L-SHELL ELECTRONS. II. Gavrila, M. (Univ. of Pittsburgh); Tugulea, M. N. Rev. Roum. Phys.; 20: No. 3, 209-230(1975).

A numerical computation is presented of the analytic cross sections obtained previously for Compton scattering by electrons bound in the 2s and 2p states of an atom, in the nonrelativistic dipole approximation. A hydrogen-like model was used. In both cases the cross sections are of the form $d^2\sigma = (r_0^2/2)\,(C_1 + C_2\cos^2\theta)\,dk_2 d\Omega_2$, where k_1 and k_2 are the energies of the initial and final photons measured in Z^2x Rydberg units, and θ is the scattering angle of the photon. The coefficients C are functions of k_1 and k_2. It is first shown that for the 2p case the analytic formulas predict a resonance in the scattered photon spectrum at an energy equal to that of the K_α emission line ($k_2 = 3/4$ in the approximation). This striking feature exists for an atom with a filled K-shell and is independent of the approximations used in the calculation. Then, the relative magnitude of the coefficients C is studied analytically for $k_2 \to 0$. This is followed by the discussion of the numerical methods and results. The incident photon energies considered lie in the interval $0.30 < k_1 < 10$. For each value of k_1 the coefficients C were computed for a number of values $k_2 (0 < k_2 < k_1 - 1/4)$ and extensive results are given. The results for the 2s and 2p cross sections are compared with each other and with those for the 1s case; the comparative values are given. (auth)

4188 INVARIANTS AND GREEN'S FUNCTIONS OF A RELATIVISTIC CHARGED PARTICLE IN ELECTROMAGNETIC FIELDS. Dodonov, V. V.; Malkin, I. A.; Man'ko, V. I. (Lebedev Inst. of Physics, Moscow). Lett. Nuovo Cim.; 14: No. 7, 241-244 (18 Oct 1975).

Previous general methods are applied to relativistic equations in external fields for various combinations of uniform electric and magnetic fields and the fields of plane waves, and it is shown that these methods enable one to obtain exact Green functions in all mentioned cases by means of a very simple procedure. Also one obtains exact results in some new interesting cases. Only the Klein–Gordon equation is considered. (JFP)

4189 TEST OF CHARM THROUGH LEPTOPRODUCTION. Kang, K.; Hashim Rizvi, S. M. A. (Brown Univ., Providence, RI). Lett. Nuovo Cim.; 14: No. 7, 253-257(18 Oct 1975).

A simple and direct test is presented for the presence of the charmed quark in the nucleon through electro- and neutrino production off nucleons and nuclei. In particular, the quark–parton model is used to give a simple derivation of two local relations among the five lepto-production structure functions for the two cases of quark–parton model with and without the charmed quark, and then the two are compared. It is assumed that Bjorken scaling is valid in the deep inelastic region for both the cases of the quark–parton model. Also the spin of the quark–partons is taken to be $\frac{1}{2}$, so that the Callan–Gross relation holds. (JFP)

4190 EFFECT OF WEAK INTERACTIONS IN ELECTRON SCATTERING BY NUCLEONS. Flambaum, V. V. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz.; 22: No. 2, 338-342(Aug 1975). (In Russian)

Cross sections of elastic and inelastic scattering of polarized electrons by polarized protons are obtained taking into account weak interactions. (auth)

4191 CHARGE ASYMMETRY IN DISTRIBUTION OF MUONS PRODUCED IN HADRONIC COLLISIONS. Sushkov, O. P. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz.; 22: No. 2, 343-345 (Aug 1975). (In Russian)

The charge asymmetry due to neutral weak currents is considered in the distribution of muons produced in hadronic collisions. The effect is estimated in the framework of the parton model for the processes $pn \to \mu^+\mu^- X$, $pp \to \mu^+\mu^- X$, $\bar{p}p \to \mu^+\mu^- X$, $\pi \pm N \to \mu^+\mu^- X$. (auth)

4192 CALCULATION OF THE $\gamma\gamma \to \pi\pi$ PROCESS AMPLITUDE IN QUANTUM CHIRAL THEORY. Volkov, M. K.; Pervushin, V. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 22: No. 2, 346-355(Aug 1975). (In Russian)

Amplitude of the process $\gamma\gamma \to \pi\pi$ is calculated in the quantum chiral-type theory for energies $\sqrt{s} \ll 1.2$ GeV. The pion polarizability is determined. (8 figures) (auth)

4193 PROOF OF THE DESER–GILBERT–SUDARSHAN REPRESENTATION. Geshkenbein, B. V.: Komech, A. I. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 22: No. 2, 416-427(Aug 1975). (In Russian)

The Deser–Gilbert–Sudarshan representation (DGSR) for the functions $W_i(\nu,q^2)$ (i = 1,2) describing the electroproduction process is considered as equations determining the spectral functions $h_i(\alpha,\alpha)$ in terms of the values of $W_i(\nu,q^2)$ in the physical region of the electroproduction channel. It is shown that if $W_i(\nu,q^2)$ satisfy the conditions of microcausality and spectrality then the equations for $h_i(\alpha,\alpha)$ have solutions in class of the Schwarz temperated distributions and so DGSR is proved. Formulae are obtained expressing the spectral functions $h_i(\alpha,\alpha)$ in DGSR in terms of $W_i(\nu,q^2)$ in physical region of the electroproduction channel. (1 figure) (auth)

4194 POMERON FACTORISATION AND THE REACTION $\gamma N \to \phi N$. Dass, G.V. (Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany); Fraas, H. Ann. Phys. (N.Y.) 92: No. 2, 315-339 (Aug 1975).

Because of the suitability of $\gamma N \to \phi N$ for studying the Pomeron, we systematically investigate the tests for Pomeron factorisation possible in this rather clean reaction, particularly from the more feasible experiment which measures the ϕ-density-matrix, and also an experiment measuring the recoil nucleon polarisation; the complete set of initial polarisation configurations has been considered. For any two-body parity-conserving process, a simple consequence of factorisation is *M*-purity which asymtotically corresponds to purely natural or purely unnatural parity in the crossed channel. Factorisation tests, therefore, include *M*-purity tests, but *M*-purity does not necessarily imply factorisation. For the ϕ-decay density-matrix we give all the possible factorisation tests, and show that our tests are exhaustive. A separate measurement of the recoil nucleon polarisation is shown to complement adequately the information obtained from the ϕ-decay density-matrix in the factorising case. For the ϕ-density matrix, some of the *M*-purity tests refer to dominant amplitudes and persist even if *s*-channel meson-helicity-conservation (which is experimentally true approximately) holds exactly. These tests should be easy to perform. The tests which invoke factorisation more crucially than only *M*-purity do not persist in that manner; these refer to the helicity nonconserving amplitudes. However, factorisation for such small amplitudes could be advantageously tested here, because of their being masked by the large amplitudes elsewhere.

The factorisation tests for the ϕ-density-matrix can be used to distinguish a pure Regge pole type Pomeron from (a) an *M*-pure "cut-

pole mixture" type Pomeron or an *M*-impure (hence nonfactorising) "cut-pole mixture" type Pomeron and also (b) a factorising "cut-pole mixture" type Pomeron or a nonfactorising "cut-pole mixture" type Pomeron. Here we have taken departure from relative reality of all amplitudes as the defining criterion for a "cut-pole mixture." Such tests would require polarised photons and/or targets. (auth)

4195 LESSONS ON e^+e^- ANNIHILATION FROM SIMPLE CHAIN EMISSION MODELS. Craigie, N.S. (II. Institut für Theoretische Physik der Universität Hamburg); Walsh, T.F. Ann. Phys. (N.Y.) 92: No. 2, 340-376 (Aug 1975).

The dearth of solvable models for $e+e^-$ annihilation often reduces one to excessively qualitative considerations, leaving obvious dynamical questions open. We discuss here various aspects of chain-emission models that can be cast into solvable form. In such models the virtual photon decays into a link (a pion, for example) and some state (e.g., an off-shell vector meson) which decays by sequentially shedding further links. Topics include the scaling behavior in such models (including how it is broken near $\omega=0$), neutral/charged distributions, the effect of internal quantum numbers, and, in a particularly simple version of the model, the two-particle distributions. In particular, we show how a large neutral to charged energy ratio can arise. Finally, we discuss variants on such models arising from possible varity in the links of the chain, (i.e., multichannel effects and the nonlinear effects arising from the branching of a chain into chains). (auth)

4196 WEAK INTERACTIONS IN $e^+ + e^- \to \mu^+ + \mu^-$. Cung, V.K. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19174). Phys. Rev. D 12: No. 3, 926-930 (1 Aug 1975).

The effects of the first-order neutral weak current in the reaction $e^+ + e^- \to \mu^+ + \mu^-$ are briefly reviewed. It is shown that the study of the front-back asymmetry and the polarization of the outgoing muon can provide considerable information about the nature of the neutral current associated with electron and muon. The effects of second-order charged weak interactions in $e^+ + e^- \to \mu^+ + \mu^-$, which can simulate first-order neutral-weak-current effects, are calculated in the Georgi-Glashow model and are shown to be smaller by at least a factor α, the fine-structure constant. (auth)

4197 BOUND ON THE RADIUS OF THE *C*-, *T*-VIOLATING ELECTROMAGNETIC INTERACTION FROM AN ANALYSIS OF THE CHRIST-LEE ASYMMETRY IN THE SECOND RESONANCE REGION. Goldberg, H. (Department of Physics, Northeastern University, Boston, Massachusetts 02115). Phys. Rev. D 12: No. 3, 818-822 (1 Aug 1975).

Heuristic arguments are given that the *C*-, *T*-violating resonant electroexcitation amplitudes in the second resonance region are $\sim (R_K/R_J)$ times the *C*-, *T*-conserving amplitudes, where R_K (R_J) is a typical interaction radius for the *C*-, *T*-violating (conserving) electromagnetic interaction. This result allows the use of an existing amplitude analysis in order to estimate that the expected Christ-Lee asymmetry in this energy region should be about $(R_K/R_J) \times$ (30 to 40%) for $q^2 \sim -0.5$ (GeV/c)^2. The experimental upper bound ($\sim 2\%$) (ma 2%) then gives a bound $R_K/R_J < 1/10$, far lower than any similar bound obtained through The experimental upper bound (ma 2%) then gives a bound $R_K/R_J < 1/10$, far lower than any similar bound obtained through the present limits on η^0 decay asymmetries. This result is also in agreement with the bound $R_K/R_J \lesssim 1/20$ obtained by previous authors in a dispersive calculation of the electric dipole moment of the neutron. Such small radii are shown to have unfavorable implications for the theory, and these are briefly discussed. (auth)

4198 LEPTONIC PROCESSES IN A SCALAR MODEL OF WEAK INTERACTIONS. Dicus, D.A. (Center for Particle Theory, University of Texas, Austin, Texas 78712); Teplitz, V.L. Phys. Rev. Lett. 35: No. 12, 807-810 (22 Sept 1975).

$\nu_\mu e$ scattering, ϕe scattering, $e^+e^- \to \mu^+\mu^-$ asymmetry, and $e^+e^- \to \mu^+\mu^-$ muon polarization are calculated for a renormalizable model of weak interactions mediated by scalar bosons B^+, B^0, and $\bar{B}^0$. The predictions differ considerably from those of other weak-interaction theories. (auth)

4199 MEASUREMENT OF THE ELECTRON-DEUTERON ELASTIC-SCATTERING CROSS SECTION IN THE RANGE $0.8 \leq q^2 \leq 6$ GeV^2. Arnold, R.G.; Chertok, B.T.; Dally, E.B.; Grigorian, A.; Jordan, C.L.; Schütz, W.P.; Zdarko, R. (American University, Washington, D. C. 20016); Martin, F.; Mecking, B.A. Phys. Rev. Lett. 35: No. 12, 776-779 (22 Sept 1975).

We report preliminary results of elastic *e-d* scattering at large momentum transfer performed at the Stanford Linear Accelerator Center with use of two high-resolution spectrometers in coincidence. Our results are in sharp disagreement with the meson-exchange calculations, they are in rough agreement with the nonrelativistic potential models, and they are in agreement with the predictions of the quark dimensional-scaling model which pictures the deuteron as a bound state of six quarks at large momentum transfer. (auth)

4200 UNIFIED MODEL OF CURRENT-HADRONIC INTERACTIONS. II. Moffat, J.W.; Wright, A.C.D. (Department of Physics, University of Toronto, Toronto, Canada). Phys. Rev. D 12: No. 3, 765-775 (1 Aug 1975).

An analytic model of current-hadronic interactions is used to make predictions which are compared with recent data for vector-meson electroproduction and for the spin density matrix of photoproduced ρ^0 mesons. The ρ^0 and ω electroproduction cross sections are predicted to behave differently as the mass of the virtual photon varies; the diffraction peak broadens with increasing $-q^2$ at fixed ν and narrows with increasing energy. The predicted ρ^0 density matrix elements do not possess the approximate *s*-channel helicity conservation seen experimentally. The model is continued to the inclusive electron-positron annihilation region, where parameter-free predictions are given for the inclusive process $e^+ + e^- \to \bar{p}$ + hadrons. The annihilation structure functions are found to have nontrivial scale-invariance limits. By using total cross-section data for e^+e^- annihilation into hadrons, we predict the mean multiplicity for the production of nucleons. (auth)

4201 LINE PROFILES AND MAGNETIC INTENSIFICATION IN MAGNETIC STARS. Havnes, O. (Univ. of Tromsoe, Norway) Moe, O. K. Astron. Astrophys.; 42: No. 2, 269-272(Aug 1975).

Line profiles with Zeeman analyzer and without have been computed for a 8000°K magnetic star using the theory of Unno (1956). Different orientations of the star and its magnetic field and different values of the magnetic field strengths have been considered. For a weak Fe4260 line we find that magnetic intensification can introduce errors of about 0.25 dex in abundance. The variable magnetic field as a magnetic Ap star rotates can produce variations in the apparent equivalent width of a few times ten percent in a star of homogeneous atmospheric composition. The effect of the magnetic field on the line profiles is large and we find it unlikely that reliable values for micro and macroturbulence can be found by conventional non-magnetic analysis. (auth)

Weak

Refer also to abstract 4616.

4202 (BNL-20433) CONSEQUENCES OF UNITARITY AND ANALYTICITY FOR WEAK INTERACTIONS. Dicus, D. A.; Teplitz, V. L. (Texas Univ., Austin (USA). Center for Particle Theory; Brookhaven National Lab., Upton, N. Y. (USA); Virginia Polytechnic Inst., Blacksburg (USA). Dept. of Physics). 1975. 14p. (CONF-750955-1). Dep. NTIS $4.00.

From conference on gauge theories and modern field theory; Boston, Massachusetts, USA (26 Sep 1975).

One considers the implications of the fact that weak two body scattering amplitudes, when calculated to all orders in any renormalizable model, should exhibit unitary, analytic, "Mandelstam" behavior. One discusses from this point of view, the existence of neutral currents, the suppression of nu/sub mu/e elastic scattering, and the possibility of lepton hadron resonances. A brief review is given of the predictions for lepton-lepton scattering of two models in which Mandelstam behavior is explicitly realized. (auth)

4203 (ORO-3992-235) VIOLATION OF UNITARITY IN WEINBERG'S UNIFIED THEORY WITH BILINEAR GAUGE CONDITIONS. Hsu, J. P.; Sudarshan, E. C. G. (Texas Univ., Austin (USA). Center for Particle Theory). Oct 1975. 27p. Dep. NTIS $5.00.

The usual formalism for non-Abelian gauge theories is not completely satisfactory. Calculations show that the usual formalism for Weinberg's unified gauge theory with a bilinear gauge condition leads to violation of unitarity, contrary to general formal proofs of unitarity. In contrast, the Lagrange multiplier formalism for this theory gives rise to unitary amplitudes; their unitarity was checked explicitly at the 1-loop and the 2-loop levels. This shows the general validity of the Lagrange multiplier formalism and its advantages over the usual formalism. (auth)

4204 (ORO-3992-237) SPIN ZERO EXCHANGE MODEL OF WEAK INTERACTIONS. Dicus, D. A.; Segre, G. C.; Teplitz, V. L. (Texas Univ., Austin (USA). Center for Particle Theory). Oct 1975. 65p. Dep. NTIS $5.50.

A renormalizable model in which weak interactions are mediated by spin-zero exchange rather than by spin-one exchange is studied. The lowest order diagrams for mu and beta decay are box diagrams. Neutrino cross sections of leptons and hadrons are calculated for the effective charged and neutral currents of the model. Weak corrections to e^+e^- yields mu^+mu^- and higher order contributions to mu decay are also calculated. Neutral current effects are predicted to be small for neutrinos on lepton targets and large for e^+e^- yields mu^+mu^-; their strength is fixed by nu-hadron scattering. In particular, there is a sizeable suppression of nu/sub mu/e scattering and a large enhancement of the asymmetry in e^+e^- yields mu^+mu^-. The only troublesome prediction is a parameter-free value of one for the ratio sigma(nu/sub mu/ + N yields nu/sub mu/ + X)/sigma(anti nu/sub mu/ + N yields anti nu/sub mu/ + X). On the

whole, however, the model provides a sensible, renormalizable alternative to the gauge theories. (auth)

4205 COMMENTS ON $I=1/2$ FINAL STATES IN NEUTRAL-CURRENT REACTIONS. Sakurai, J.J. (Department of Physics, University of California, Los Angeles, California 90024). Phys. Rev. Lett. 35: No. 15, 1037-1040 (13 Oct 1975).

New tests of neutral-current models are proposed for $I=1/2$ final states produced in neutrino-induced reactions. The isoscalar analog of the conserved-vector-current hypothesis is also discussed. (auth)

4206 PRODUCTION OF STRANGE PARTICLES BY A NEUTRAL CURRENT AND THE QUARK HYPOTHESIS. Frankfurt, L.L. (Leningrad Institute of Nuclear Physics, USSR Academy of Sciences). JETP Lett. 21: No. 11, 324-325 (5 June 1975).

It is shown that in *SU* (4) symmetry one can expect an increased number of strange particles in processes in which neutral current takes part. (auth)

4207 RADIATIVE CORRECTIONS TO PION DECAYS. Gregor, J. M. New York; Columbia Univ. (1974). 111p. University Microfilms Order No. 75-16,114.

Thesis (Ph. D.).

A calculation is made of the effect of the hadronic structure of the pion on the radiative corrections to the branching ratio pi yields e nu/pi yields mu nu. The correction due to the axial weak current is calculated by constructing a phenomenological Lagrangian for the pi, A_1, and rho mesons with minimally broken chiral symmetry and by using field-current identities. The phenomenological Lagrangian contains 5 free parameters which are determined by the pion decay rate, the rho and A_1 masses, and the decay rates rho yields e^+e^- and rho yields 2pi. It is first used to calculate the pion charge radius, the axial form factor for pi yields e nu gamma, and the rates A_1 yields rho pi (longitudinal and transverse); then the axial correction to pi yields e nu/pi yields mu nu is calculated to be 3×10^{-4}. The correction to the branching ratio due to the vector weak current is calculated using the π^0 yields 2 gamma decay rate and the assumption that the process occurs through a quark triangle diagram, yielding a value which is dependent on the log of the cut-off (quark mass) and is estimated to be 5×10^{-4}. (Diss. Abstr. Int., B)

4208 LEPTONIC DECAYS OF HEAVY PSEUDOSCALAR MESONS. Antoine, H.; Pestieau, J. (Univ., Louvain, Belgium). Lett. Nuovo Cim.; 14: No. 6, 185-188(11 Oct 1975).

The new particles $\psi(3105)$ and $\psi(3695)$ are identified as the I = O members of a heavy-meson nonet and the wide bump at 4100 MeV, denoted by ψ^{11} as the neutral I = 1 member of the corresponding octet. It is proposed that these hadronic states are built from an SU(3) triplet of heavy quarks which includes an isodoublet and an isosinglet just like ordinary hadrons are supposed to be made from the (p,n,λ) quarks. (JFP)

4209 COMMENT ON BOUNDS FOR ν TO ANTI ν RATIOS OF NEUTRAL WEAK CROSS SECTIONS. Gronau, M. (Israel Inst. of Tech., Haifa). Lett. Nuovo Cim.; 14: No. 6, 204-208 (11 Oct 1975).

The scalar and pseudoscalar and the vector and axial-vector processes are considered in order to demonstrate a way in which the coexistence of (S,P) and T terms in the neutral-current interaction may show up in the measurements of total cross sections. The amplitude of $\nu_\mu e^- \to \nu_\mu e^-$ and deep inelastic neutrino scattering on nuclei are considered, and the total cross sections found. (JFP)

4210 MONOPOLES IN A NON-ABELIAN GAUGE FIELD THEORY. Venturi, G. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 14: No. 7, 233-236 (18 Oct 1975).

It is found that the introduction of magnetic charge into a non-Abelian gauge theory can be done in a manner analogous to the Abelian case, once a proper identification of the conserved current is made. (JFP)

4211 TEST OF SCALING IN NEUTRINO INTERACTIONS. Kulikov, A. V.; Stroganov, Yu. G. (Inst. of High Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 22: No. 2, 335-337(Aug 1975). (In Russian)

A method is presented to handle the results of the neutrino deep-inelastic scattering which does not need a knowledge of the neutrino energy. (auth)

4212 DESCRIPTION OF PION DECAYS IN QUANTUM CHIRAL THEORY. Volkov, M. K.; Pervushin, V. N. (Joint Inst. for Nuclear Reserach, Dubna, USSR). Yadern. Fiz.; 22: No. 2, 366-372(Aug 1975). (In Russian)

The amplitudes of the decays: (1) $\pi^{(\pm)} \to \mu^{(\pm)}\nu(e^{(\pm)}\nu)$, (2) $\pi^0 \to \gamma\gamma$, (3) $\pi^{(\pm)} \to e^{(\pm)}\nu\gamma(\mu^{(\pm)}\nu\gamma)$, (4) $\pi^{(\pm)} \to \pi^0 e^{(\pm)}\nu$ are calculated in the quantum chiral theory in the one-loop approximation. The structure constants h_A and h_V of the decay $\pi^{(\pm)} \to \mu^{(\pm)}\nu\gamma$ related to the contribution from the vector and axial currents are expressed through the pion polarizability β (the reaction $\gamma\gamma \to \pi^{(\pm)}\pi^{(-)}$) and the decay constant f of the reaction $\pi^0 \to \gamma\gamma$ in consistence with the current algebra. The ratio $\gamma = h_A/h_V$ agrees with the experimental value $\gamma = 0.4$. The renormalization of the coupling constant depending on the pion mass is found. (6 figures) (auth)

4213 RELATIVISTIC KINETIC THEORY. de Groot, S. R. (Univ., Amsterdam). Rev. Mex. Fis.; 23: No. 4, 405-422(Dec 1974). (In French)

Relativistic kientic theory is based on the relativistic transport equation, for which the covariance properties are discussed. Using this equation, the macroscopic conservation laws and the law of entropy are deduced. The transport and absorption coefficients are determined for simple systems and a mixture of massive particles. The method of calculation using the series expansion of associated Laguerre polynomials valuable for arbitrary cross section of particles. By means of an analogous but modified procedure, the transport coefficients of a gas of massless particles, neutrinos, are likewise calculated. A number of results are furnished for concrete systems of two particles. (tr-auth)

4214 POINT TRANSFORMATION AND RENORMALIZATION IN THE UNITARY GAUGE FOR NON-ABELIAN FIELDS. Mainland, G.B.; O'Raifeartaigh, L. (Dublin Institute for Advanced Studies, 10 Burlington Road, Dublin 4, Ireland). Phys. Rev. D 12: No. 2, 489-502 (15 July 1975).

It is shown by means of a model that the renormalization and unitary gauges for non-Abelian fields can be connected by a point transformation, and this fact is used to construct a formal proof of renormalization in the unitary gauge. The formal proof is then verified by demonstrating that for a fourth-order on-shell scattering process the *S* matrix calculated directly in the unitary gauge is exactly equal to that calculated in the renormalization gauge. The calculation is refined to the point where it becomes purely graphical and this allows one to see by inspection how the cancellation of divergences occurs in the unitary gauge, and to trace this cancellation to the spontaneous-symmetry-breaking mechanism in the Lagrangian. (auth)

4215 RESTRICTIONS ON THE STRUCTURE OF THE $|\Delta S|=1$ NONLEPTONIC HAMILTONIAN. Golowich, E.; Holstein, B.R. (Department of Physics and Astronomy, University of Massachusetts, Amherst, Massachusetts 01002). Phys. Rev. Lett. 35: No. 13, 831-834 (29 Sept 1975).

Restrictions concerning the chiral structural of the $|\Delta S|=1$ nonleptonic weak Hamiltonian are derived by studying kaon and hyperon decay amplitudes via current algebra and partial conservation of axial-vector current. (auth)

4216 ESTIMATE OF POSSIBLE CONSERVED-VECTOR-CURRENT VIOLATION IN PION β DECAY. Niyogi, K.; Ray, A.K. (Department of Physics, Visva-Bharati University, Santiniketan-731235, West Bengal, India). Phys. Rev. D 12: No. 3, 892-895 (1 Aug 1975).

The ratio f_- / f_+, which provides a measure of the conserved-vector-current violation in the pion β decay, is calculated in the symmetrical theory of weak and electromagnetic interactions, neglecting, of course, the strong interactions of pions. It is shown that the contribution to this ratio coming from second-order radiative corrections to pion β decay is finite and $\sim 10^{-3}$ with the appropriate choice of the gauge-boson masses. (auth)

4217 COMMENT OF THE DECAY OF ψ (3.1) INTO EVEN-*G*-PARITY STATES. Chanowitz, M.S. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. D 12: No. 3, 918-922 (1 Aug 1975).

We discuss what can be learned about the dynamics of the new particles by studying the decays of ψ (3.1) into even-*G*-parity states. (auth)

4218 INELASTIC NEUTRINO SCATTERINGS: NONSCALING EFFECTS OF LARGE ω. Hayot, F.; Nieh, H.T. (Institute for Theoretical Physics, State University of New York, Stony Brook, New York 11794). Phys. Rev. Lett. 35: No. 12, 810-813 (22 Sept 1975).

Stimulated by the SPEAR e^+e^- —annihilation data and recent results of the neutrino experiment of Aubert *et al.* Benvenuti *et al.*, we speculate on the various aspects of inelastic neutrino scatterings at large ω, or small x. We conjecture that there will be a breakdown of Bjorken scaling at small x, and, relatedly, an increase of the "excess" events at higher incident neutrino energies. The y dependence in the region of small x is also discussed. (auth)

Strong (General)

Refer also to abstracts 4308 and 4557.

4219 (JINR–E2-9105) TRANSVERSE MOMENTUM DEPENDENCE OF AVERAGE MULTIPLICITY. Matveev, V. A.; Sisakyan, A. N.; Slepchenko, L. A. (Joint Inst. for Nuclear Research, Dubna

(USSR)). 1975. 23p. (CONF-750742-3). Dep. NTIS (US Sales Only) $4.50.

From 6th international colloquium on multiparticle dynamics; Oxford, UK (Jul 1975).

The behavior of the mean associated multiplicity of the secondary particles as function of the transverse momentum is considered. New scaling regularities of the cross sections of the semi-inclusive reactions are predicted and compared with the experimental data obtained in the two-meter propane chamber of JINR, irradiated by π^--mesons with p = 40 GeV/c at the Serpukhov accelerator. (auth)

4220 (JINR-P2-9100) BELTRAMI MODEL OF THE LOBACHEVSKY SPACE APPLIED TO THE KINEMATICS OF THE HADRON REACTIONS. Hen, V. P. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 18p. (In Russian). Dep. NTIS (US Sales Only) $4.50.

The Beltrami model of the Lobachevsky space was applied to the kinematics of the many-particle reactions. The Beltrami model is applicable to the analytic calculations due to the straight lines and planes of Lobachevsky expressed in linear equations in the Beltrami coordinates. The expressions are presented for those geometrical images of the Lobachevsky space that were used in the analysis of the reaction $\pi^-p \to p\pi^+\pi^-\pi^-$ at 5 GeV/c. (auth)

4221 QUARK CONFINEMENT, RISING TRAJECTORIES, AND ASYMPTOTIC BEHAVIOR OF FORM FACTORS. Müller-Kirsten, H.J.W. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). Phys. Rev. D 12: No. 4, 1103-1122 (15 Aug 1975).

Several long-range force models of quark confinement are considered, with particular emphasis on gluon exchange analogous to linear and harmonic potentials. First, the nonrelativistic case is discussed and the connection between the rise of the Regge trajectories and the power of the potential is derived. Then semirelativistic and relativistic equations are considered. It is shown that in each case the rising trajectories result from large quark-gluon coupling constants. It is also shown that an asymptotic power decrease of bound-state form factors follows only if the interaction contains an additional Coulomb- or Yukawa-type part, and only in the spacelike or the timelike domain. The significance of infrared cutoffs is examined, violations of unitarity are pointed out, and the behavior in the static limit is discussed. (auth)

4222 PION PRODUCTION FROM A CLASSICAL SOURCE: TRANSPORT AND HYDRODYNAMICAL PROPERTIES. Cooper, F.; Sharp, D.H. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). Phys. Rev. D 12: No. 4, 1123-1131 (15 Aug 1975).

We discuss how to determine the hydrodynamic and transport properties of a pion field produced in a high-energy collision. It is shown that a Boltzmann-type equation can be obtained for a relativistic generalization of the Wigner distribution function. In simple models, one can construct the expectation value of the normal-ordered energy-momentum tensor from the second moments of this distribution function. For a $\lambda\phi^4$ theory, treated in the Hartree approximation, we show that the transport equation for the pion field is similar, in the limit $\hbar \to 0$, to that for a single specie plasma, treated in the Vlasov approximation. We show that if pions are produced in a coherent state, the hydrodynamic properties of the field are those of an ideal fluid. In particular, pion production by a c-number source provides a realization in field theory of Landau's hydrodynamical model. (auth)

4223 SU(3) SYMMETRY OF COUPLING CONSTANTS IN STRONG INTERACTIONS. Mathis, H. B. Lafayette, IN; Purdue Univ. (1974). 124p. University Microfilms Order No. 75-17,245.

Thesis (Ph. D.).

As an introduction, several well known applications of SU(3) to the dynamics of strong interactions are discussed. It is stressed that the exact-symmetry formalism was found to require modifications in order to achieve satisfactory agreement with experimental data. This leads to the concept of SU(3)-symmetric coupling constants. Their usefulness for describing resonance decays, two-body scattering amplitudes, and Regge residues is demonstrated. At the same time, several well established topics of strong-interaction physics are reviewed, in order to arrive at a reasonably self-contained exposition, and to establish a unified framework for subsequent applications of the symmetry principle. The new results are obtained by applying the concept of SU(3)-symmetric coupling constants to inclusive fragmentation processes of nucleons and to those meson-baryon scattering amplitudes for which Odorico's linear-zero hypothesis leads to symmetry-violating predictions. The general inclusive reaction a + b yields c + X is considered in the a fragmentation region. Several well known hypotheses concerning early scaling in cases of ($a\bar{c}$) or ($ab\bar{c}$) states of exotic Y (hypercharge) or I_3 (isospin) are extended to states of nonexotic Y and I_3 and exotic SU(3) representations. Several testable predictions are made for the case where particle a is a nucleon, and b is a pseudoscalar meson. These predictions may be useful in studying both the SU(3) symmetry of various Regge couplings and the effects of mass differences in SU(3) multiplets. (Diss. Abstr. Int., B)

4224 DOES "HADRONIC ETHER" EXIST FOR VERY HIGH ENERGY HADRON COLLISION PHENOMENA. Koshiba, M. (Tokyo Univ. (Japan). Faculty of Science). J. Phys. Soc. Jpn.; 38: No. 2, 305-307(Feb 1975).

In connection with the result of CERN-ISR experiment, a question is raised regarding the existence of "hadronic ether" for very high energy hadron collision phenomena. (auth)

4225 THEORY OF MIRROR PARTICLES. Mori, K. (Saitama Univ., Urawa, Japan); Nakamura, H. Lett. Nuovo Cim.; 14: No. 7, 261-263(18 Oct 1975).

A theory of giant hadrons based on the SU(3) model of strong interactions. This is generalized, and it is considered that the assemblies with minimum or nearly minimum representation can also form bound states and are observable as real heavy hadrons. First the concept of the closed shell is introduced which is an assembly of six quark-antiquark pairs and whole S-state configurations are filled up. This closed shell is called the sigma meson. The basic assumption is that the virtual sigma mesons are produced very abundantly in vacuum and the transitions via the sigma meson can occur. A hadron H is considered with quantum number Q. Then if the constituent quarks and antiquarks of H are removed from the sigma meson, the residual bound state has the conjugate quantum number $\bar{Q}$ to Q. Such a possible bound state is called the mirror particle $\hat{H}$ of H. (JFP)

4226 PRODUCTION OR PARTICLES WITH LARGE TRANSVERSE MOMENTUM IN A SIMPLE QUARK MODEL. Levin, E. M.; Ryskin, M. G. (Leningrad Inst. of Nuclear Physics). Yadern. Fiz.; 22: No. 2, 428-431(Aug 1975). (In Russian)

4227 NONRELATIVISTIC FIELD THEORY FOR STRONG COUPLING. Gross, E.P. (Department of Physics, Brandeis University, Waltham, Massachusetts 02154). Phys. Rev. D 12: No. 2, 421-426 (15 July 1975).

We study the Hamiltonian for a nonrelativistic nucleon with Yukawa coupling to a scalar meson field. The nucleon self-energy is logarithmically divergent. It is known that one can isolate the divergent part by a canonical transformation, but this technique is feasible only for simple field theories. We study the theory by a systematic strong coupling in inverse powers of the coupling constant e. The leading term in the energy is of order e^4 and corresponds to classical particlelike solutions. The terms of order e^2 represent a generalized meson-pair theory. The zero-point energy shift yields the logarithmically divergent energy. The residual Hamiltonian contains scattering resonances, and techniques are developed to study the resonances. (auth)

Strong (Baryon No. = 0)

4228 (DESY-75/19) ARE THE PSI's REALLY PURE S WAVE STATES? Krammer, M.; Krasemann, H. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (F.R. Germany)). Jul 1975. 17p. Dep. NTIS (US Sales Only) $4.00.

The $\psi'(3.7)$ and $\psi''(4.15)$ are considered as mixtures of the 2^3S_1 and 1^3D_1 states in a harmonic oscillator model, in order to explain the series of the leptonic decay widths of (J,ψ), ψ' and ψ''. The spectrum of P wave states and the radiative width of ψ' are discussed in view of a new heavy meson. The mixing model is also applied to the excitations of the S(770). (auth)

4229 (ORO-3992-234) SPECTRUM GENERATING SU(3) AND SU(4) AND THE LEPTONIC DECAY OF rho, omega, phi, J/psi. Bohm, A. (Texas Univ., Austin (USA). Center for Particle Theory). 1975. 22p. Dep. NTIS $4.25.

SU(e) and SU(4) are considered as spectrum generating groups and applied to the decays of rho yields e anti e, omega yields e anti e, phi yields e anti e, J/psi yields e anti e. The results are compared with the experimental data, which leads to predictions of the form of the electromagnetic transition operator (currents). (auth)

4230 (RL-75-103) DIFFICULTIES FOR SU(N) QUARK MODELS OF THE NEW PARTICLES. Colglazier, E. W.; Barnes, K. J.; Hey, A. J. G.; Zia, R. K. P. (Science Research Council, Chilton (UK). Rutherford Lab.). Jun 1975. 14p. (CONF-750676-1). Dep. NTIS (US Sales Only) $4.00.

From conference on difficulties for SU(N) quark models of the new particles; Zakopane, Poland (5 Jun 1975).

If preliminary experimental results on the new particles are confirmed (primarily the $\psi\eta$ decay of the ψ'), and if conventional theoretical prejudices are accepted, it is shown that Harari's SU(6) model is the minimal N-quark model (with hidden color) which can accommodate these constraints. (auth)

4231 STRANGE PARTICLE PRODUCTION IN ANTI pp ANNIHILATIONS AT 1.23 TO 1.35 GeV/c. Handler, T. New Brunswick, NJ; Rutgers--the State Univ. (1975). 129p. University Microfilms Order No. 75-17,450.

Thesis (Ph. D.).

The Brookhaven National Laboratory 31 in. hydrogen filled bubble chamber was exposed to beams of antiprotons at momenta of 1.224, 1.256, 1.286, 1.313, and 1.350 GeV/c. The total exposure consisted of approximately 650,000 pictures divided evenly among the five momenta. All frames were scanned for interactions with at least one visible K_1^0 and a total of 5855 events in a restricted fiducial region were available for analysis in the final sample. The primary purpose of this experiment was to study the K_1^0 production dynamics and in particular to search for any effects that could be attributed to direct channel resonance formation. The total cross section for annihilation into strange particles with at least one visible K_1^0 is found to be 2069 +- 45 mu barns for the combined momentum data with the cross sections at the individual momenta being consistent with this average cross section. The cross sections for the various final states and resonance channels do not show any significant effect that could be attributed to direct channel resonance formation. Copious resonance formation is observed in the majority of the final states with the K*(892) resonance being predominant. The $F_1(1540)$ meson which had been seen in other experiments in the final state $K_1^0K^0pi^+pi^-$ is not seen in this experiment. The D^0 and E^0 mesons are observed in several of the final states along with the various anti KK threshold effects. Evidence is seen for a $K^{+-}pi^{-+}$ resonance at 1315 MeV/c^2 in the final state $K^0{}_1K^{+-}pi^{-+}$. (Diss. Abstr. Int., B)

4232 PION PRODUCTION IN ANTI p-p ANNIHILATION. Minami, S. (Osaka City Univ. (Japan). Dept. of Physics). Prog. Theor. Phys. (Kyoto); 52: No. 5, 1601-1609(Nov 1974).

We study the expression of 2n-prong cross section with which experimental results for multiplicity distribution of pion production in $\bar{p}$-p annihilation can be reproduced. On the basis of the expression, some models for $\bar{p}$-p annihilation are suggested and compared with the reaction mechanism for pion production in $\bar{e}$-e annihilation. (auth)

4233 PRODUCTION RATES AND MOMENTUM DISTRIBUTIONS OF NEW HEAVY PARTICLES ACCORDING TO THE WHOLE-REGION FORMULA. Kinoshita, K. (Univ. of Bielefeld, Ger.); Mizouchi, M.; Tashiro, T.; Noda, H. Lett. Nuovo Cim.; 14: No. 6, 209-215(11 Oct 1975).

The problem of production rates and momentum distributions of new heavy particles is discussed according to the whole-region formula, assuming the quartet scheme $(p_0, n_0, \lambda_0, p_0^-)$ of constant urbaryons. The particles $\psi(3105)$, $\psi(3695)$, $\psi(4.1)$, and D mesons produced in pp interactions are considered. (JFP)

4234 $\pi\pi$ I = O S-WAVE SCATTERING LENGTH FROM A UNITARIZED VENEZIANO AMPLITUDE. Daly, L. (Univ. Coll., Dublin). Lett. Nuovo Cim.; 14: No. 6, 216-218(11 Oct 1975).

Using a previous N/O decomposition on a Veneziano amplitude for $\pi\pi$ scattering the a_0^0 scattering length is predicted. The main steps in the calculation are described. (JFP)

4235 HOW CROSSING AFFECTS THE ANALYTIC RELATIONSHIP BETWEEN LOW ENERGY $\pi\pi$ AMPLITUDES AND THEIR ASYMPTOTIC BEHAVIOUR. Pennington, M.R. (Rutherford Laboratory, Chilton, Didcot, Oxon, OX11 00X, England). Ann. Phys. (N.Y.) 92: No. 1, 164-200 (July 1975).

Different physical assumptions about the asymptotic behavior of $\pi\pi$ amplitudes are realised in the different number of subtractions involved in fixed t dispersion relations for the various amplitudes and their inverses. The fact that each new dispersion relation must be consistent with s-t crossing leads to a number of conditions relating low energy $\pi\pi$ amplitudes to their high energy behaviour. These are discussed in detail. Such relationships supplement finite energy sum rules with which they are compared. The dispersive sum rules, crossing conditions, and finite energy sum rules we discuss are applied to recent phenomenological solutions to Roy's equations and shown not to narrow the presently accepted range of threshold parameters. These results are in marked contrast to the conclusions of other recent studies. To complete the study of finite energy sum rules we consider the behaviour of the isospin zero t-channel amplitude and estimate the asymptotic $\pi\pi$ total cross-section. We present evidence to suggest that the pomeron is late-developing in meson-meson scattering. (auth)

4236 FAILURE OF INELASTIC *N/D* EQUATIONS TO GENERATE THE ρ RESONANCE. Tryon, E.P. (Department of Physics and Astronomy, Hunter College of The City University of New York, New York, New York 10021). Phys. Rev. D 12: No. 3, 759-764 (1 Aug 1975).

The effective left cut of the $\pi\pi$ P wave is rigorously determined by comparing the usual partial-wave dispersion relation with a new dispersion relation of the kind derived by Roskies and Roy. A recent experimental result for the inelasticity below $M_{\pi\pi} = 1.9$ GeV is inserted into the Frye-Warnock *N/D* equations. The solutions are nonresonant, even when the inelasticity is increased by 50% over the experimental value. Because of the rigorous basis for the effective left cut, I conclude that the ρ resonance is not generated by forces in the $\pi\pi$ channel. (auth)

Strong (Baryon No. = 1)

Refer also to abstract 4314.

4237 (ANL/HEP-CP-75-50) OBSERVATION OF f-f' INTERFERENCE IN pi^-p yields K^-K^+n AT 6 GeV/c. Pawlicki, A. J.; Ayres, D. S.; Diebold, R.; Kramer, S. L.; Wicklund, A. B. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-eng-38. 3p. (CONF-750858-1). Dep. NTIS $4.00.

From meeting of the ASP division of particles and fields; Seattle, Washington, USA (27 Aug 1975).

Preliminary results from a study of pi^-p yields K^-K^+n at 6 GeV/c with the Argonne Effective Mass Spectrometer are presented. The 100,000-event data sample shows a dramatic drop in the Y_4^0 moment of the K^-K^+ decay angular distribution at a K^-K^+ mass of 1500 MeV. This feature is interpreted as a result of f-f' interference, which can also explain the excess of D-wave cross section near 1450 MeV observed previously. (auth)

4238 (DESY-75/25) COMMENT ON THE PHASES OF INELASTIC PARTIAL WAVES AND THEIR COMPARISON WITH THE QUARK MODEL, THE CURRENT TO CONSTITUENT QUARK TRANSFORMATION, $SU(6)_W$, AND VECTOR DOMINANCE. Soeding, P. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (F.R. Germany)). Aug 1975. 9p. Dep. NTIS (US Sales Only) $4.00.

It is shown that the phases of inelastic πN partial wave amplitudes can be absolutely determined, using results from photoproduction. The signs obtained for the resonant amplitudes confirm the agreement with the relativistic quark model, the Melosh transformation, the broken $SU(6)_W$ scheme, and with vector dominance in the comparison with photoproduction. (auth)

4239 (JINR-E2-9170) RENORMALIZATION IN NONLINEAR CHIRAL FIELD THEORY. Kazakov, D. I.; Pervushin, V. N.; Volkov, M. K. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 27p. Dep. NTIS (US Sales Only) $5.00.

The renormalization program for nonlinear chiral theory is developed by using the superpropagator method. A number of relations between the renormalization constants (the Ward identities) is found from the requirement of chiral invariance. The strong πN-coupling and the axial coupling of β-decay in the one-loop approximation and the two-loop corrections to the pion self-energy are calculated. The calculations show that in spite of the strong πN-coupling the contributions from higher orders are relatively small (~20 to 30%). (auth)

4240 ANALYSIS OF TWO-PION PRODUCTION IN TERMS OF ONE-PION EXCHANGE (OPE) WITH ABSORPTION. Reid, A. W. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim.; 28A: No. 4, 519-537(21 Aug 1975).

The Williams' or poor man's absorption (PMA) model for absorbed-pion exchange is extended to reactions of the type $Bp \to (B\pi)(\pi p)$, where B is the beam particle (π, K, or p), and $(B\pi)$, (πp) are two-body final-state enhancements. The two decaying systems in the final state yield more information on the nature of the production mechanism. It is investigated to what extent the PMA describes the reaction and exploits the greater range of information available. (auth)

4241 MULTIPLICITY SYSTEMATICS OF π^0, K_1^0, AND Λ PRODUCED IN HIGH ENERGY COLLISIONS. Berceanu, S. (Joint Inst. for Nuclear Research, Dubna, USSR); Ponta, T. Rev. Roum. Phys.; 20: No. 2, 165-171(1975).

It is shown that the experimental data on π^0, K_1^0, and Λ multiplicities in π^- p and pp collisions can be parametrized by a unique function within the framework of the KNO semi-inclusive scaling prediction on larger energy ranges than those quoted earlier. However, the ratios of moments $\langle n^q\, n_c\rangle \langle n\rangle^{-q} \langle n_c\rangle^{-1}$ seem to increase with energy. (auth)

4242 REACTIONS OF RADIATIVE ABSORPTION OF ANTI K MESONS BY NUCLEONS IN THE LOW ENERGY REGION. Krive, I. V. (Kharkov State Univ.). Yadern. Fiz.; 22: No. 2, 356-365(Aug 1975). (In Russian)

In framework of the pole model the cross sections of processes $\bar{K}N \to \Lambda(\Sigma)\gamma$ are calculated in the low-energy region and of the reactions $\bar{K}N \to Y_{01}^*(1405)\gamma$, $\bar{K}N \to Y_{13}^*(1385)\gamma$ near the threshold. A strong sensitivity of the calculated cross sections to the radiative transition constants for low lying hyperon resonances is indicated. (1 table, 4 figures) (auth)

4243 NATURE OF SUPPRESSION OF STRANGE-PARTICLE PRODUCTION IN THE QUARK MODEL. Anisovich, V. V.; Ko-

brinskii, M. N. (Inst. of High Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 22: No. 2, 382-384(Aug 1975). (In Russian)

Experimental data on inclusive reactions show that production of strange particles is suppressed as compared with predictions of the SU(3)-symmetric quark model. It is shown in the present work that this suppression has a natural explanation in framework of the quark-parton description of the hadron interactions. With this in view, the extent to which the strange-particle production is suppressed may be determined from the data on total πN and KN interaction cross sections. The values of the cross sections, obtained in Batavia, provide an indication to that the strange/nonstrange inclusive production ratio will increase with the energy, approaching the limit, predicted by the SU(3)-symmetric model. (1 table) (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 3758, 4265, and 4323.

4244 (BNL-20533) LAMBDA^0 INCLUSIVE PRODUCTION IN SIGMA$^-$-NUCLEUS REACTIONS. Arik, E.; Cleland, W. E.; Dris, M. (Brookhaven National Lab., Upton, N. Y. (USA)). 1975. 14p. (CONF-750858-5). Dep. NTIS $4.50.

From meeting of the ASP division of particles and fields; Seattle, Washington, USA (27 Aug 1975).

A counter spark chamber experiment was done in the AGS 23-GeV/c charged hyperon beam to study LAMBDA^0 inclusive production in reactions of SIGMA$^-$ on Al, Cu, W, and Pb. Preliminary results are reported on the missing mass spectra in the reaction SIGMA$^-$ + Nucleon yields LAMBDA^0 + M^2/sub x/. The data are compared with the relevant triple Regge formalism. (auth)

4245 MØLLER WAVE OPERATOR AND OFF-SHELL *t*-MATRIX ELEMENTS FOR NUCLEON-NUCLEON INTERACTIONS. Shapiro, M. (Chemical Physics Department, Weizmann Institute of Science, Rehovot, Israel); Brumer, P. Phys. Rev. C 12: No. 4, 1371-1374 (Oct 1975).

A recently developed method for efficiently computing off-shell *t*-matrix elements is applied to the nucleon-nucleon interaction. Sample results are given for the $^1S_0$ Reid soft core potential. (auth)

4246 EXTENSIVE AIR SHOWERS OF COSMIC RAYS AND SCALE INVARIANCE IN HADRONIC INTERACTIONS AT ULTRAHIGH ENERGIES. Kalmykov, N.N.; Khristiansen, G.B. (Institute of Nuclear Physics of the Moscow State University). JETP Lett. 21: No. 11, 315-316 (5 June 1975).

It is shown that the experimental data on the number of high-energy muons in EAS do not agree with the assumption that scale invariance is preserved in hadronic interactions in the energy region 10^{15}–10^{17} eV. (auth)

4247 STUDY OF THE HALF-SHELL T-MATRIX USING ANALYTICITY AND RELATIVISTIC MESON THEORY. Reiner, M. J. College Park, MD; Univ. of Maryland (1974). 311p. University Microfilms Order No. 75-18,119.

Thesis (Ph. D.).

A fundamental theory of the half-shell T-matrix for nucleon-nucleon scattering is developed through the use of analyticity and dispersion theory. The theory is expressible directly in terms of the fundamental relativistic meson-theoretic amplitudes, which correspond to manifestly nonlocal and energy-dependent interactions and which are universal for all states of the nucleon-nucleon system. The theory is, in principle, free from unknown and arbitrary parameters, requiring as input only the observable phase shifts and inelasticities for all energies and the fundamental meson-nucleon coupling constants and their associated form factors. In addition to being able to incorporate in a very natural way the bound states, the spin coupling, the inelasticities, and the effects of the Coulomb interaction, the theory also provides a convenient framework for obtaining valuable insights into the underlying strong-interaction dynamics of the half-shell T-matrix. In light of the fact that the half-shell T-matrix is quite sensitive to the short-distance behavior of the nucleon-nucleon interaction, where the description in terms of a potential is unreliable and ambiguous, it is noteworthy that the theory provides a very general framework for going beyond the potential-theoretic description of the nucleon-nucleon interaction. A detailed study of the half-shell T-matrix in the $^1S_0$ and $^1P_1$ states is undertaken within the framework of the relativistic one-boson-exchange models, as well as the usual potential models. The high energy phase shifts and inelasticities used are deduced from the Regge-pole fits to the high energy scattering data. The sensitivity of the half-shell T-matrix to the present uncertainties in the fundamental inputs and to the inelasticities, which arise from the mesonic degrees of freedom in the intermediate states, is studied. The half-shell T-matrix so obtained is also compared to that obtained using the Reid local potential. (Diss. Abstr. Int., B)

4248 TOTAL CROSS SECTION OF PP ELASTIC SCATTERING FROM 9 TO 300 GeV/c. Bartenev, V. D.; Kuznetsov, A. A.; Morozov, B. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 22: No. 2, 317-319(Aug 1975). (In Russian)

The total cross section of pp elastic scattering in the $9 \leq p \leq 300$ GeV/c range has been calculated. (2 figures, 1 table) (auth)

4249 COMMENT ON SIGNELL AND HOLDEMAN'S $I=0$ np PHASE-SHIFT SOLUTIONS AT 330 MeV. Bryan, R. (Research Institute for Theoretical Physics, University of Helsinki, SF—00170 Helsinki 17, Finland). Phys. Rev. Lett. 35: No. 14, 967-970 (6 Oct 1975).

I point out that one of the two solutions that Signell and Holdeman published for $I=0$ np scattering at 330 MeV contradicts long-range one-pion-exchange dominance. This has interesting consequences, because recent theories of 2π exchange strongly favor this solution in the $^1D_2$ state. (auth)

4250 SCATTERING OF PIONS FROM ^{3}He AND ^{4}He CALCULATED WITH REALISTIC FORM FACTORS. Landau, R.H. (Department of Physics, University of British Columbia, Vancouver, Canada). Ann. Phys. (N.Y.) 92: No. 2, 205-231 (Aug 1975).

Pion scattering from ^{3}He and ^{4}He is examined using a lowest order theoretical optical potential including spin. The goal is to determine the properties of these nuclei to which pion scattering is sensitive. A realistic description of the nuclear ground state that incorporates the experimental trinucleon charge and magnetic form factors and the theoretical classification of the trinucleon wave function is employed, in addition to a description of the off-shell πN transition matrix based on a finite-ranged potential model and an improved pi-nucleus angle transformation. The ^{4}He calculations establish the practical validity of the optical potential and the ^{3}He calculations indicate the direction for future experiments and improvements in the theory. It is proposed that π^{-3}He scattering can provide information on the magnetic moment form factor of ^{3}He. (auth)

4251 COHERENT STATES WITH DEFINITE CHARGE AND ISOSPIN AND CLUSTER PRODUCTION. Martinis, M.; Mikuta, V. (Theoretical Physics Department, Institute "Rudjer Bošković," Zagreb, Yugoslavia). Phys. Rev. D 12: No. 3, 909-917 (1 Aug 1975).

A solvable unitary model of Auerbach *et al.* is generalized to take into account the isospin structure of the pion and the leading-particle system. The coherent-state representation is used to discuss the production of isovector objects, such as pions and resonances (or clusters). Particular attention is paid to productions when the isospin state of the ingoing and outgoing leading-particle system is fixed. The isospin analysis of the pion-pion correlation is performed by assuming both the direct-pion-emission mechanism and the cluster-emission mechanism. The slope of $\langle n_0 \rangle_{n_-}$ is predicted to increase with energy and is positive in the π-ρ and ρ-B regions (about 3/4 and about 14/17, respectively). (auth)

4252 TWO-COMPONENT MODEL FOR THE ASSOCIATED MULTIPLICITY IN INCLUSIVE REACTIONS. Alonso, J.L.; Wright, A.C.D. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). Phys. Rev. D 12: No. 3, 776-784 (1 Aug 1975).

We present a simple, two-component model for the charged multiplicity associated with the observed particle in an inclusive reaction. At small p_T the scattering is ascribed to a coherent or "soft" component, whereas at large p_T the production mechanism is assumed to be incoherent or "hard." At fixed incident energy and missing mass, the p_T dependence of $\bar{n}_c$ is given by the relative weights of hard and soft scattering, so that the multiplicity is a sensitive probe of the transition region between the two components. The model is applied to recent multiplicity data for $pp \to pX$ and $pp \to \pi^+X$ at 28.5 GeV/c, as well as to data at Fermilab and CERN-ISR energies. (auth)

4253 BARYON-BARYON SCATTERING IN A ONE-BOSON-EXCHANGE-POTENTIAL APPROACH. I. NUCLEON-NUCLEON SCATTERING. Nagels, M.M.; Rijken, T.A.; de Swart, J.J. (Institute for Theoretical Physics, University of Nijmegen, Nijmegen, The Netherlands). Phys. Rev. D 12: No. 3, 744-758 (1 Aug 1975).

From a combined analysis of nucleon-nucleon and hyperon-nucleon scattering with a one-boson-exchange-potential-model the *NN* results are presented. The model consists of local potentials due to exchanges of members of the pseudoscalar and vector meson nonets and the scalar meson ϵ taken as a unitary singlet. Effects of the large widths of the ϵ and ρ meson are included. The Schrödinger equation is solved in configuration space with phenomenological hard-core potentials at short distances. The coupling constants and hard core-radii are determined in a fit using the *NN* phase-shift analysis of the Livermore group up to 330 MeV laboratory kinetic energy and the low-energy parameters. The *NN* phase shifts are described well with χ^2/data = 2.4 (as good as the purely phenomenological potentials) and good values are obtained for the scattering length effective ranges, and deuteron parameters. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 4568.

4254 THE PCAC CONDITION IN MODELS WITH $(\bar{6}, 6)+(6, \bar{6})$ AND (8, 8) BREAKING OF CHIRAL $SU(3) \times SU(3)$ SYMMETRY. Kafiev, Yu.N. (Mathematics Institute, Siberian Division, USSR Academy of Sciences). JETP Lett. 21: No. 11, 322-323 (5 June 1975).

The consequences that ensue for $SU(2) \times SU(2)$ symmetry in models with $(\bar{6}, 6)+(6, \bar{6})$ and (8, 8) breaking of chiral $SU(3) \times SU(3)$ are considered. It is shown that large deviations ($\sigma^{**} \sim 1$ GeV) from $SU(2) \times SU(2)$ symmetry appear at $m_\pi^2 = 0$, meaning that it is impossible to introduce the PCAC condition in a consistent manner. (auth)

4255 SPONTANEOUS BREAKDOWN OF NON-ABELIAN SYMMETRY. Wyly, J. K. Milwaukee; Univ. of Wisconsin (1974). 98p. University Microfilms Order No. 75-17,816.

Thesis (Ph. D.).

The concept of symmetry in physics is discussed in general terms and the idea of spontaneous breakdown is developed in some detail. The functional formulation of field theory is introduced and discussed, along with the techniques of dynamical mapping and dynamical rearrangement of symmetry. These ideas are used to examine the spontaneously broken SU(2) symmetry of a Lorentz-scalar iso-triplet field. The Ward-Takahashi identities are derived and the Goldstone theorem verified. The local current remains conserved. Two Goldstone bosons appear in directions perpendicular to the breaking but the mass of the third particle is not fixed by the symmetry. Analysis of the case where the third particle is massless is straightforward. If this particle is considered massive, it is likely to be unstable. In any case the observable symmetry is not SU(2) but E(2). (The possibility of a stable third particle does not change the results). Careful consideration of infrared contributions explains this change. The space--time independent transformations of the Goldstone particles are considered as certain limits of spacetime dependent transformations: essentially, the SU(2) symmetry is recovered when the unobservable infrared contribution is taken into account. This limiting process does not commute with the commutator process. The case of SU(2) x SU(2) is considered using a Lorentz pseudoscalar iso-triplet field with a Lorentz scalar iso-singlet. Results analogous to the case of SU(2) are obtained and the rearranged symmetry is that of E(3). Finally, some ongoing work is described, and a few speculations and anticipations are made. (Diss. Abstr. Int., B)

4256 POSSIBLE DYNAMICAL SYMMETRY BREAKING DUE TO RADIATIVE CORRECTIONS. Ioffe, B. L.; Novikov, V. A.; Shifman, M. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 22: No. 2, 401-415(Aug 1975). (In Russian)

Possibility is studied of dynamical symmetry breaking, i.e. appearance of $\langle\varphi\rangle \neq 0$ due to radiative corrections in the scalar $\lambda\varphi^4$ theory, scalar electrodynamics and non-abelian gauge theories. It is shown that in the one-loop approximation (as well as in a number of higher approximations) the dynamical symmetry breaking is absent and the only mechanism for the spontaneous symmetry breaking is the Goldstone–Higgs–Kibble effect. (7 figures) (auth)

4257 VACUUM SYMMETRY AND THE PSEUDO-GOLDSTONE PHENOMENON. Georgi, H. (Lyman Laboratory, Harvard University, Cambridge, Massachusetts 02138); Pais, A. Phys. Rev. D 12: No. 2, 508-512 (15 July 1975).

In the context of gauge theories with spontaneous symmetry breakdown induced by the Higgs phenomenon, a simple theorem is stated which gives conditions under which pseudo-Goldstone particles may occur. These conditions are broader than the occurrence of accidental symmetry and contain the latter case as a special instance. We analyze an example in which the gross features of the vector- and the scalar-meson mass spectra are determined by quantum effects. (auth)

4258 STUDY OF $(3, 3^*) \oplus (3^*, 3) \oplus (8, 8)$ SYMMETRY BREAKING IN A LINEAR σ MODEL. Geddes, H.B.; Graham, R.H. (Department of Physics, University of Toronto, Toronto, Ontario, Canada). Phys. Rev. D 12: No. 3, 855-887 (1 Aug 1975).

Employing several linear SU(3) σ models developed by Schechter, Ueda, and collaborators, we study the effects of various possible chiral-symmetry–breaking terms in the Lagrangian belonging to the $(3, 3^*) \oplus (3^*, 3) \oplus (8, 8)$ representations of SU(3) X SU(3). In this approach the pseudoscalar mesons (π, K, η, η') and scalar mesons (ϵ, κ, σ, σ') are assigned to $(3, 3^*) \oplus (3^*, 3)$ and the model is used to describe the scalar and pseudoscalar mass spectra, scalar meson decays, $\eta' \to \eta\pi\pi$, and the $\pi\pi$ and πK scattering lengths. Inclusion in the Lagrangian of isospin-violating terms and an effective nonleptonic weak interaction allow treatment of electromagnetic and weak effects as well. We find that a form of chiral symmetry breaking suggested by Okubo is at least as successful as the Gell-Mann–Oakes–Renner $(3, 3^*) \oplus (3^*, 3)$ form. The scheme of Sirlin and Weinstein is also satisfactory. Pure (8, 8) symmetry breaking is unacceptable within the context of the present model. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstract 4427.

Applications (Strong)

Refer also to abstracts 4474 and 4475.

4259 (DESY–75/27) FIVE QUARKS, NEW PARTICLES, AND V + A CURRENTS. Achiman, Y.; Koller, K.; Walsh, T. F. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (F.R. Germany)). Aug 1975. 10p. Dep. NTIS (US Sales Only) $4.00.

An SU(5) model for the new heavy mesons, with a charge $-\frac{1}{3}$ fancy quark in addition to a charge $+\frac{2}{3}$ charmed quark. Besides interpreting the two narrow vector mesons J/ψ and ψ' as $c\bar{c}$ and $f\bar{f}$ bound states and accounting for present data in a natural way, the model has three new fancy vector mesons in addition to the charmed ones of the SU(4) model, at most two new C = P = +mesons ($c\bar{c}$, ^3P_J, J = 0,1) between J/ψ and ψ', with suppressed radiative decays $\psi' \to {}^3P_J + \gamma$, a state near 4.6 GeV in e^+e^-, decaying mostly to fancy mesons if it is broad or perhaps charmed mesons if it is narrow, V + A weak currents and a large anomaly in $\bar{\nu}N$ reactions, a possible heavy lepton. (auth)

4260 BARYON RESONANCES AND LIGHTLIKE CHIRAL ALGEBRA. Ida, Masakuni; Tajima, T. (Kyoto Univ. (Japan). Research Inst. for Fundamental Physics); Yamawaki, K. Prog. Theor. Phys. (Kyoto); 52: No. 5, 1583-1600(Nov 1974).

Close connections which may exist between the baryon spectrum and pionic decays of baryon resonances are shown in terms of lightlike chiral algebra $SU(3)_l \otimes SU(3)_l$. As a phenomenological scheme for baryon classification we consider two sets of four Regge families. The scheme, which is based on the concepts of nondegenerate parity partners and Regge daughters, can well explain the observed spectrum. In order to study complicated representation mixing, a bloc hypothesis is introduced by the help of the four-family scheme and observed pionic decays of various resonances. A bloc is a minimal set of states for approximate saturation of Adler-Weisberger relations. We give a more precise meaning to the hypothesis in terms of eigenvectors of the $SU(3)_l \otimes SU(3)_l$ invariant part of the mass-squared operator P^2. Complete knowledge of the matrix elements of P^2 for the eigenvectors can simultaneously determine physical masses and lightlike pion vertices. (auth)

4261 CHARMED BARYONS IN A QUARK–DIQUARK MODEL. Lichtenberg, D. B. (Indiana Univ., Bloomington). Nuovo Cim.; 28A: No. 4, 563-576(21 Aug 1975).

A quark-diquark model of baryons is generalized to include charmed baryons within the framework of the broken-symmetry groups SU_8 and $SU_8 \times O_3$. Mass relations are obtained for the baryons belonging to the lowest-lying level of SU_8, and some qualitative features of the higher levels are given. (auth)

Scattering Theory

Refer also to abstract 4223.

4262 (BNL-20353) LINEAR, FUNCTIONAL EQUATION APPROACH TO THE PROBLEM OF THE CONVERGENCE OF PADE APPROXIMANTS. Baker, G. A. Jr. (Brookhaven National Lab., Upton, N. Y. (USA)). 6 Aug 1975. 14p. (CONF-750575-1). Dep. NTIS $4.00.

The Pade approximant problem is related to a (not necessarily orthogonal) projection of a linear functional equation of the Fredholm type. If the kernel is of trace class and its upper Hessenberg form is tridiagonal (this class includes Hermitian operators), then it is proven that not only do the diagonal Pade approximants converge, but so do their numerators and denominators separately. The generalization of these results to C/sub p/ classes of compact operators is given. For kernels which are not only compact, but also satisfy an additional mild restriction, a pointwise convergence theorem is proven. The application of these results to quantum scattering theory is indicated. (auth)

4263 (NP-20701) NEW DEVELOPMENTS IN DISPERSION THEORY. Volume 1. Dynamical Singularities and Amplitude Analysis. Hamilton, J.; Petersen, J. L. (Nordisk Inst. for Teoretisk Atomfysik, Copenhagen (Denmark)). Jan 1975. 224p. NORDITA, Copenhagen.

The discussion of dynamical singularities and amplitude analysis in dispersion theory includes polarization and helicity, fixed-t and finite contour dispersion relations. (JFP)

4264 MINIMAL THREE-BODY EQUATIONS WITH FINITE-RANGE EFFECTS. Amado, R.D. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19174). Phys. Rev. C 12: No. 4, 1354-1357 (Oct 1975).

In this paper it is shown how the fundamental quantum mechanical constraints of unitarity and analyticity in three-body final states can be realized when finite-range effects, like centrifugal barriers, are important. The resulting equations are remarkably similar to the usual separable-potential scattering equations. (auth)

4265 PHENOMENOLOGICAL CONSEQUENCES OF THE SHIELDED FIXED-POLE POMERON AT VERY HIGH ENERGIES. Fujisaki, H.; Tsukahara, K. (Rikkyo Univ., Tokyo (Japan). Dept. of Physics). Prog. Theor. Phys. (Kyoto); 53: No. 1, 161-174 (Jan 1975).

Phenomenological consequences of shielding-cut mechanism of Oehme type are investigated within the framework of eikonal approximation. Under the assumption of the usual dipole form factor for the hadronic matter density, it is shown that eikonalization of a fixed-simple-pole Pomeron with two Arnold and Barnett's shielding cuts provides a simple and natural generalization of the Chou-Yang droplet model and yields a successful explanation of all of the recent CERN-ISR results on p-p diffraction scattering. Our fit to the data is performed by using the only one adjustable parameter. Quantitative predictions about phenomenological features of elastic p-p scattering are also given at extremely high energies such as ISABELLE energies. On the basis of these observations, it is argued that the Pomeronic amplitude is well described by an absorbing disc at very high energies, the effective radius of which shows no appreciable energy dependence and is approximately fixed at 1.0 fm, and the total magnitude of which slowly grows to an asymptotic value with increasing energy. (auth)

4266 POMERON AND OTHER SINGLE DUAL LOOPS WITHOUT UNPHYSICAL STATES. Collins, P. V.; Friedman, K. A. (Weizmann Inst. of Science, Rehovoth, Israel). Nuovo Cim.; 28A: No. 4, 475-486(21 Aug 1975).

The single nonplanar dual loop is recalculated in the critical dimension of space-time. This becomes possible because of a recent analysis of the nature of physical states in the dual model which enables one to understand when $\tau(k)$, the on-shell projection operator of Brink and Olive, becomes Lorentz covariant. One calculates the pomeron loop and it is shown that the pomeron becomes a factorizable pole in the critical dimension, as previously conjectured. It is indicated how the results extend to the Neveu-Schwarz model. (auth)

4267 THRESHOLD BEHAVIOR AND THE GENERALIZED JOST FUNCTION FORMALISM. Stihi, M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 20: No. 2, 157-163 (1975).

The relativistic partial-wave scattering problem is reformulated in the frame of the f/f method so as to satisfy automatically the threshold behavior. The corresponding singular integral equation for the generalized Jost function is deduced. (auth)

4268 THREE-BODY BOUND-STATE PROBLEM: CONNECTION BETWEEN THE PARTIAL WAVE FUNCTION APPROACH AND FADEEV'S T-MATRIX METHOD. Magyari, E. Rev. Roum. Phys.; 20: No. 2, 197-199(1975).

It is pointed out that the so called "partial wave-function approach" to the three-body bound-state problems, is equivalent to the method of Fadeev equations. (auth)

4269 FORMALISM OF RELATIVISTIC MANY BODY THEORY. Norton, R. E.; Cornwall, J. M. (Univ. of California, Los Angeles). Ann. Phys. (N.Y.); 91: No. 1, 106-156(May 1975).

The thermodynamic potential is constructed as an effective action functional of the various n point amplitudes (n less than or equal to 4). One of the functionals is used to obtain the equations of state as simple, convergent expressions involving the conventionally renormalized charges and masses. (auth)

4270 RESONANTLY COUPLED NONLINEAR EVOLUTION EQUATIONS. Ablowitz, M. J. (Clarkson Coll. of Tech., Potsdam, NY); Haberman, R. J. Math. Phys. (N. Y.); 16: No. 11, 2301-2305(Nov 1975).

A differential matrix eigenvalue problem is used to generate systems of nonlinear evolution equations. They model triad, multi-triad, self-modal, and quartet wave interactions. A nonlinear string equation is also recovered as a special case. A continuum limit of the eigenvalue problem and associated evolution equations are discussed. The initial value solution requires an investigation of the corresponding inverse-scattering problem. (auth)

4271 INCORPORATING CASTILLEJO-DALITZ-DYSON POLES AS INPUT IN *N/D* CALCULATIONS. Daboul, J. (Physics Department, Ben Gurion University of the Negev, Beer Sheva, Israel). Phys. Rev. D 12: No. 3, 888-891 (1 Aug 1975).

A generalized integral equation for ReN (z) is derived in which all the necessary information for determining Castillejo-Dalitz-Dyson (CDD) poles is incorporated as input, and for which this information can be taken directly from phase-shift data—just as the inelasticity function η (z) can. Hence, *N/D* calculations with CDD poles are as "dynamical" or rather as empirical as those without, in that they do not require adjustable CDD parameters. (auth)

4272 BOUNDS ON ELASTIC ABSORPTIVE PARTS. Singh, V. (Tata Institute of Fundamental Research, Bombay, India 400005). Ann. Phys. (N.Y.) 92: No. 2, 377-394 (Aug 1975).

We reduce the general problem of obtaining bounds on elastic absorptive parts of a scattering amplitude subject to unitarity restrictions and any number of constraints involving partial wave amplitudes linearly to a form where it can be directly applied to any such problem. A series of bounds on absorptive parts for positive momentum transfer square t, within the Lehmann-Martin ellipse, is derived. These involve a knowledge of the first few momentum transfer derivatives of the absorptive part in the forward direction, i.e., $t=0$. Upper and lower bounds on the higher t-derivatives of the absorptive part at $t=0$ are also given. (auth)

PHYSICS (LOW-TEMPERATURE)

Superfluidity

4273 HIGH ENERGY NEUTRON SCATTERING AND THE BOSE CONDENSATE IN He(II). Aleksandrov, L.; Zagrebnov, V. A.; Kozlov, Zh. A.; Parfenov, V. A.; Priezzhev, V. B. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz.; 68: No. 5, 1825-1833(May 1975). (In Russian).

An analysis of the spectrum of deep inelastic scattering of neutrons ($k \approx 14.1$ Å^{-1}) is carried out on the basis of the regularized Gauss–Newton iteration process. As a mathematical model a double gaussian shape is employed, it being assumed that the scattering law can be represented by two gaussian curves corresponding to contributions from the condensate and overcondensate parts. From the viewpoint of the statistical criterion for T = 4.2 K a model with a single Gaussian is the more satisfactory, this indicating that there is no Bose condensate at this temperature. A model with two Gaussians is the best at T = 1.2 K, the Bose condensate fraction being $\rho_0/\rho = 0.036 \pm 0.014$. (auth)

Superconductivity

Refer also to abstracts 3436, 3463, 3476, 3480, 3503, 3514, 3523, 3524, 3534, 3538, 3539, 3543, 3551, 3554, 3556, 3588, 3667, and 3668.

4274 (LA-tr-75-27) SHORT COMMUNICATION ON THE CONNECTION BETWEEN TRANSITION TEMPERATURE AND CRITICAL CURRENT DENSITY OF SUPERCONDUCTING WIRES ON THE BASIS OF INTERMETALLIC PHASES OF THE beta-W TYPE. Rassmann, G.; Muller, P. Translated from J. Less-Common Met.; 39: 335-339(1975). 9p. Dep. NTIS $4.00.

The effect of structure and structure defects on T/sub c/ and j/sub c/ was theoretically considered. The relation between T/sub c/ and j/sub c/ was experimentally tested on powder-metallurgy prepared compacts of Nb_3Sn, Nb_3Al, and $Nb_3(Al, Ge)$. The results obtained in the measurement of the critical current in a field of 40 kA/cm and a measurement temperature of 4.2°K as a function of T/sub c/ (T/sub c/ equals T_0 - T/sub c/) were graphed and compared with results obtained by other investigators. (JSR)

4275 TEMPERATURE DEPENDENCE OF THE PHONON FREQUENCIES IN Nb_3Sn AND V_3Si. Gor'kov, L.P.; Dorokhov, O.N. (L. D. Landau Institute of Theoretical Physics, USSR Academy of Sciences). JETP Lett. 21: No. 11, 310-312 (5 June 1975).

The softening of the phonon frequencies, which was observed in [1,2] for a wide interval of wave vectors, is explained using the model of [3] with two peaks in the state density, under the assumption that the Fermi level is located near one of the peaks. The proximity of the sample to the martensitic transition favors superconductivity, since this proximity reflects the proximity of the chemical potential to the position of one of the peaks. (auth)

4276 THERMOELECTRIC POWER IN SUPERCONDUCTORS. Artemenko, S.N.; Volkov, A.F. (Institute of Radio and Electronics, USSR Academy of Sciences). JETP Lett. 21: No. 11, 313-314 (5 June 1975).

It is shown theoretically that in the presence of a temperature gradient there is produced in a superconductor an electric field that falls off exponentially with increasing distance from the superconductor boundary. The depth of penetration of the field greatly exceeds the correlation length and coincides with the length characterizing the "mixing of branches." (auth)

4277 RESPONSE OF A PURE SUPERCONDUCTOR TO A SLOWLY VARYING PERTURBATION. Aronov, A. G.; Gurevich, V. L. (Physicotechnical Inst., Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 16: No. 9, 1722-1726(Mar 1975).

Translated from Fiz. Tverd. Tela; 16: No. 9, 2656-2665(Sep 1974).

A system of equations is derived for the response of a pure superconductor to external perturbations which vary slowly in time and are slightly inhomogeneous spatially. The system includes, in addition to the Maxwell equations, an equation for the supperconducting gap, a kinetic equation for the distribution function of normal excitations of the superconductor, and a continuity equation for the electron density. In the case of a superconductor the last equation does not follow from the kinetic equation for the excitations; it is independent of the kinetic equation. The kinetic equation is derived by the Keldysh diagram technique. The H theorem and the law of energy conservation in the superconductor are derived from the kinetic equation. The kinetic coefficients calculated from the kinetic equation satisfy the Onsager relation. (auth)

4278 RELAXATION OF ELECTRONS ON THE IMPURITIES IN SUPERCONDUCTORS. Galaiko, V. P. (Physical-Technical Inst. of Low Temperature, Kharkov). Teor. Mat. Fiz.; 22: No. 3, 375-390(Mar 1975). (In Russian)

In the method of kinetic equations with self-consistent field for the generalized electron density matrix of superconductor, the time evolution of density matrix is studied, taking into account the scattering of electrons on impurities, in the case when the ratio of the mean free path to the correlation radius of superconducting electrons is arbitrary. To this end the equations for real electron propagation functions (retarded and advanced) in general non-stationary and spatially inhomogeneous case are constructed with the aid of multiple scattering theory and the separation of the coherent and non-coherent contributions vanishing after averaging over impurities coordinates is performed. Character of asymptotic states is analyzed, which arise on the first stage of the evolution (before the relaxation with respect to energy), when the characteristic frequency representation of the density matrix with arbitrary non-equilibrium distribution function over frequencies is established (the distribution function being the analogue of the classical distribution function over energy). Kinetic equations for this function are constructed, describing slow relaxation to the thermo-dynamical equilibrium state. (auth)

4279 UNEXPECTED VARIATION OF THE COULOMB PSEUDOPOTENTIAL. Will, T. A. (Universidad Nacional Autonoma de Mexico, Mexico City). Rev. Mex. Fis.; 23: No. 4, 391-401(Dec 1974).

The Coulomg pseudopotential, as determined from tunneling measurements, is found to vary over a wider range in superconducting fcc PbTl and PbBi than accounted for by currently accepted theory. This variation is shown to reflect structure in the density of states, as estimated from the rigid band model. (1 table, 2 figures) (auth)

4280 THE ANISOTROPY OF H_{c2} AND ITS IMPLICATIONS TO GRAIN-BOUNDARY FLUX PINNING IN V_3Si. Kramer, E.J.; Knapp, G.S. (Argonne National Laboratory, Argonne, Illinois 60439). J. Appl. Phys. 46: No. 10, 4595-4596 (Oct 1975).

We report that V_3Si has an extremely large anisotropy in H_{c2}. This anisotropy is large enough to account for the observed strength of grain-boundary pinning observed in polycrystalline V_3Si. (auth)

4281 CRITICAL CURRENTS IN GRANULAR SUPERCONDUCTORS. Ekin, J.W. (Cryogenics Division, Institute for Basic Standards, National Bureau of Standards, Boulder, Colorado 80302). Phys. Rev. B 12: No. 7, 2676-2681 (1 Oct 1975).

A relatively simple principle is experimentally demonstrated for producing extremely low critical-current density materials for application in quantum flux-flow devices. Essentially the technique consists of making the scale of structural disorder in the material small compared with the vortex core size. The smaller this ratio, the smaller the effects of bulk pinning, and the smaller the resulting critical-current density. Data for this study were obtained using superconducting granular aluminum films evaporated in a cylindrical geometry designed to eliminate edge-pinning effects. The data show J_c to exhibit a sharp minimum as a function of grain size, with the lowest values of J_c occurring in those films having the smallest ratio $\langle D\rangle/(\xi_0 l)^{1/2}$. Here $\langle D\rangle$ is the average grain size, ξ_0 is the BCS coherence length, and l is the electronic mean free path. The normal-state resistivity ρ_n can be used as an index of $\langle D\rangle/(\xi_0 l)^{1/2}$ for the granular aluminum system, with the lowest critical-current densities occurring in films prepared to have a ρ_n of about 10 $\mu\Omega$ cm. In addition to discussing the dependence of the critical current on microstructure, data on the temperature dependence and electric field dependence of J_c are presented. (auth)

4282 LOCALIZED DESCRIPTION OF SUPERCONDUCTIVITY. II. STRONG-COUPLING FORMULATION. Birnboim, A.; Gutfreund, H. (The Racah Institute of Physics, The Hebrew University of Jerusalem, Jerusalem, Israel). Phys. Rev. B 12: No. 7, 2682-2689 (1 Oct 1975).

A localized description of superconductivity in narrow-band metals, proposed by Appel and Kohn, is extended to the strong-coupling case. Equations similar, but not identical, to the Eliashberg equations are obtained. These equations are solved numerically and the results are represented by a semiphenomenological formula for T_c. A microscopic calculation of the electron-phonon coupling constant in the localized representation, based on measured phonon frequency-distribution curves and augmented-plane-wave band calculations, is described. Results for V, Nb, and Ta yield values of λ within a factor of 2 from the expected ones, without any adjustable parameter. (auth)

4283 ACOUSTIC COUPLING OF THIN SUPERCONDUCTING FILMS. Schuller, I. (Solid State Science Division, Argonne National

Laboratory, Argonne, Illinois 60439); Gray, K.E. Phys. Rev. B. 12: No. 7, 2629-2633 (1 Oct 1975).
Rev. B 12: No. 7, 2629-2633 (1 Oct 1975).

The acoustical coupling of two thin superconducting films forming a tunnel junction was measured. The experiment was performed by photoexciting quasiparticles in one film and studying the resulting change in the energy gaps. The results show that the phonon escape parameter from lead to tin agrees with calculated values and there is an indication of an additional escape mechanism in the lead films. (auth)

4284 FLUX-FLOW IN NEARLY PURE LOW-κ SUPERCONDUCTORS. Bardeen, J.; Sherman, R.D. (Physics Department, University of Illinois, Urbana, Illinois 61801). Phys. Rev. B 12: No. 7, 2634-2639 (1 Oct 1975).

A theory of flux flow useful for low-κ superconductors is given where the electrodynamics is nonlocal. Fields and chemical potential gradients are induced by a transport current which causes the vortex to move with velocity $\vec{v}_L$. These are determined self-consistently by the requirement that they generate a supercurrent to correspond to the displacement of a static vortex and compensate for scattering of thermally excited quasiparticles. Making use of an approximate analytic solution for a static vortex by Kramer and Pesch, it is shown that for the case of pure ($l \gg \xi_0$) superconductors at low temperatures ($T \lesssim 0.5\, T_c$) there is no backflow. The component of $\vec{v}_L$ in the direction of the transport current is the transport velocity, a result of the Hall effect on the bound states in the vortex core. (auth)

4285 ELECTRONIC PROPERTIES OF POLYMERIC SULFUR NITRIDE. Schlüter, M.; Chelikowsky, J.R.; Cohen, M.L. (Department of Physics, University of California, Berkeley, California 94720). Phys. Rev. Lett. 35: No. 13, 869-872 (29 Sept 1975).

We present a three-dimensional band-structure calculation of $(SN)_x$ using the empirical pseudopotential scheme. The density of states, Fermi surface, and optical spectrum are calculated. Estimates for the electron-phonon coupling constant λ are given and the increase of T_c with pressure is discussed. The assumption of an electron-phonon mechanism for superconductivity in $(SN)_x$ is consistent with our results. (auth)

PHYSICS (NUCLEAR)

4286 (AECD/MISC-4) ANNUAL TECHNICAL REPORT, JULY 1972–JUNE 1973. (Atomic Energy Center, Dacca (Bangladesh)). Dec 1974. 154p. Dep. NTIS (US Sales Only) $10.75.

This is the first technical report of the Atomic Energy Center, Dacca, since the independence of Bangladesh. Needless to say, the war had a great effect on the programs of the center. This report is arranged according to the following scheme: physical sciences (chemistry, computer technology, electronics, experimental nuclear physics, health physics, technical physics, theoretical physics), bio-sciences (genetics, radiobiology), general and engineering services, research facilities offered to universities, seminars/lectures, publications, and scientific personnel of AECD. Items with significant amounts of information are listed separately by title. (RWR)

For titles of individual papers see: 2590, 2635, 3152, 3163–3165, 3186–3188, 3261–3265, 4368, 4369, and 4387.

4287 (CONF-751101-20) ONE MORE ALGORITHM FOR GENERATING ELASTIC AND INELASTIC SCATTERING MATRICES. Grimesey, R. A. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). 1975. 3p. Dep. NTIS $4.50.

From joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

Much effort in recent years has been spent on attempts to optimize the numerical problem of calculating elastic and inelastic multigroup scattering matrices from basic ENDF/B data. This paper presents an algorithm which minimizes the amount of data manipulation and approximation required. The algorithm is based on avoiding time-consuming transformations between c.m. and lab coordinates for the differential cross section and the additional requirement with the ETOG algorithm to manufacture Legendre expansion coefficients if tabular distributions are given. The new algorithm was incorporated into the ETOP code, which generates elastic and inelastic scattering matrices for the 68-group Phrog II fast spectrum code. CPU time is roughly a factor of 4 faster than the ETOG algorithm in the most favorable cases for ETOG. (RWR)

4288 (IKF–34) ANNUAL REPORT, 1974. Bass, R.; Groeneveld, K. O.; Kessel, W.; Muellner, M.; Schmidt-Boecking, H.; Schopper, E.; Stelzer, K.; Steuer, E. (comps.). (Frankfurt Univ. (F.R. Germany). Inst. fuer Kernphysik). 1974. 144p. (In German). Dep. NTIS (US Sales Only) $10.25.

A summary of the scientific activities of the Institute for Nuclear Physics of Frankfurt am Main University for the year 1974 is given. Scientific work was carried on in the following fields: nuclear reactions and nuclear structure, heavy-ion physics, atomic collision processes, neutron diffractometry and spectroscopy, solid-state particle track detectors, nuclear analysis methods and mass spectroscopy, ion source development, electronics, data processing, and radiation safety. Individual reports containing sufficient information are listed separately by title. (RWR)

For titles of individual papers see: 3987–3991, 4324, 4370, 4388, 4399, and 4423.

4289 (LBL-4000) NUCLEAR CHEMISTRY. Annual Report, 1974. Conzett, H. E.; Edelstein, N. M.; Tsang, C. F. (eds.). (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1975. Contract W-7405-eng-48. 434p. Dep. NTIS $10.60.

The 1974 Nuclear Chemistry Annual Report contains information on research in the following areas: nuclear science (nuclear spectroscopy and radioactivity, nuclear reactions and scattering, nuclear theory); chemical and atomic physics (heavy ion-induced atomic reactions, atomic and molecular spectroscopy, photoelectron spectroscopy and hyperfine interactions); physical, inorganic, and analytical chemistry (x-ray crystallography, physical and inorganic chemistry, geochemistry); and instrumentation. Thesis abstracts, 1974 publication titles, and an author index are also included. Papers having a significant amount of information are listed separately by title. (RWR)

For titles of individual papers see: 2559–2562, 2636, 2680–2686, 3009, 3081, 3118, 3701, 3954, 3992–3996, 4305, 4325–4331, 4360, 4371, 4389, 4390, 4400–4403, 4424–4427, 4436–4441, 4452–4456, 4471, and 4472.

4290 (NP–20526) INSTITUTE FOR NUCLEAR STUDY ANNUAL REPORT, JANUARY 1974–DECEMBER 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study). 1974. 151p. Dep. NTIS (US Sales Only) $10.75.

The work of the Institute in 1974 is briefly summarized in the preface. The body of the text is organized around the various groups in the Institute, as follows: Low-energy physics division (accelerators, instrumentation for experiments, physics), High-energy physics division (electron synchrotron, instrumentation for experiments, experiments with the electron synchrotron), Synchrotron radiation laboratory (absolute measurements of synchrotron orbital radiation, absorption measurements of gases in the xuv region, construction of SOR-RING), Cosmic-ray physics division (air shower group, emulsion group, space physics group), Theoretical physics division, Chemistry laboratory, Computer facilities, and General services. Lists of staff, publications, colloquia, budgets, etc., are also included. Individual items containing significant amounts of information are listed separately by title. (RWR)

For titles of individual papers see: 3082, 3083, 3714–3717, 4103, 4104, 4332–4337, 4361, 4373, 4391–4393, 4404–4411, 4428, 4442, and 4443.

Neutron Interactions with Matter

Refer also to abstracts 3062 and 4511–4513.

4291 (ANL/NDM-17) SAMPLE-SIZE EFFECTS IN FAST-NEUTRON GAMMA-RAY PRODUCTION MEASUREMENTS: SOLID-CYLINDER SAMPLES. Smith, D. L. (Argonne National Lab., Ill. (USA)). Sep 1975. Contract W-31-109-eng-38. 64p. Dep. NTIS $5.50.

The effects of geometry, absorption and multiple scattering in (n,Xgamma) reaction measurements with solid-cylinder samples are investigated. Both analytical and Monte-Carlo methods are employed in the analysis. Geometric effects are shown to be relatively insignificant except in definition of the scattering angles. However, absorption and multiple-scattering effects are quite important; accurate microscopic differential cross sections can be extracted from experimental data only after a careful determination of corrections for these processes. The results of measurements performed using several natural iron samples (covering a wide range of sizes) confirm validity of the correction procedures described herein. It is concluded that these procedures are reliable whenever sufficiently accurate neutron and photon cross section and angular distribution information is available for the analysis. (13 figures, 5 tables) (auth)

4292 (EUR–5273d-e-f(Vol.1), pp 191-225) CONSIDERATIONS CONCERNING NEUTRON DOSIMETRY. Bichsel, H. (Univ. of Washington, Seattle). Mar 1975.

From 2nd symposium on neutron dosimetry in biology and medicine; Neuherberg/Munich, F.R. Germany (30 Sep 1974).

In proceedings of second symposium on neutron dosimetry in biology and medicine. I.

Norms needed to achieve accurate absolute values of neutron dose with cavity chambers are discussed. A review of the principles of cavity dosimetry is given. Current knowledge of W-values, stopping power and kerma is evaluated. An understanding of the difference in stopping powers between a gas and a solid of identical composition is achieved. (Typically, S_{gas} is 5-10% higher than S_{solid}). Determination of gamma ray contributions to neutron dose is achieved with microdosimetric measurements, with an uncertainty of 10-20%. (3 figs., 12 tables, 40 refs.) (auth)

4293 (EUR–5273d-e-f(Vol.1), pp 263-285) MIXED FIELD DOSIMETRY WITH IONIZATION CHAMBERS AND PROPORTIONAL COUNTERS. Maier, E.; Knesewitsch, P.; Burger, G. (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Neuherberg, Ger.). Mar 1975.

From 2nd symposium on neutron dosimetry in biology and medicine; Neuherberg/Munich, F.R. Germany (30 Sep 1974).

In proceedings of second symposium on neutron dosimetry in biology and medicine. I.

Mixed field dose measurements have been performed in free space and within phantoms for several selected neutron energies at a 3 MeV - Van De Graaff accelerator and for a ^{252}Cf source. The instruments used were ionization chambers and a tissue equivalent proportional counter. A quantitative error analysis is presented and the uncertainties in the determination of the total dose and separate dose components are given as a function of varying relative gamma-dose.

4294 (ORNL-TM-5020) ONE-DIMENSIONAL FAST-NEUTRON TRANSPORT BENCHMARK CALCULATIONS. Ching, J.; Oblow, E. M. (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 95p. Dep. NTIS $5.45.

A series of state-of-the-art fast-neutron transport calculations were made for several simple shield materials of interest to the Defense Nuclear Agency. The calculations should serve as benchmarks for testing newly evaluated neutron cross-section data and multigroup libraries. Results are presented for one-dimensional spherical systems of iron, air, and concrete (SiO_2). The results include detailed flux spectra, broad-group fluxes versus distance, and convergence tests for representations of the P/sub l/ scattering kernel and for space, angle, and energy grids. The methods employed in converging the solutions differ from previous benchmark calculations in that sensitivity and point-energy techniques were used to determine the energy grid for the final results. (auth)

4295 (ORNL-tr-4019(DR)) FAST ADIABATIC NEUTRON SPIN FLIP. Taran, Yu. V. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. Translation by M. Gerrard of JINR-P3-8577. 10p. Dep. NTIS $4.50.

Some possible applications of the fast adiabatic spin flip in neutron physics are considered. The equation of the neutron spin motion in a static magnetic field with the constant gradient in the presence of an oscillating field has been solved by numerical methods. A quantitative figure of merit for the parameters of these fields for the effective neutron spin reverse is obtained by the method of adiabatic passage through resonance. (3 figures) (auth)

4296 (ORNL-tr-4020) OPTIMIZATION OF A STORAGE VARIANT OF EQUIPMENT FOR MEASURING THE STORAGE VARIANT OF THE ELECTRICAL DIPOLE MOMENT OF A NEUTRON USING ULTRACOLD NEUTRONS. Taran, Yu. V. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1974. Translation by M. Gerrard of JINR-Bl-13-8441. 9p. Dep. NTIS $4.50.

A regime of operation of equipment for measuring the electrical dipole moment (EDM) of a neutron using ultracold neutrons in a storage variant is considered. Two methods of optimizing the equipment are discussed: one based on minimization of the EDM measurement error and the error of a pair of adjacent measurements with different relative orientations of the magnetic and electric fields (cycle error). The practical equivalence of the two approaches is shown for actual situations. (5 figures) (auth)

4297 STATE SYSTEM FOR ENSURING THE METROLOGICAL ACCURACY OF NEUTRON MEASUREMENTS IN NUCLEAR-PHYSICS INSTALLATIONS. Agaletskii, P. N.; Vasil'ev, R. D.; Yaryna, V. P. Meas. Tech.; 17: No. 12, 1802-1804(Dec 1974).

Translated from Izmer, Tekh.; No. 12, 5-7(Dec 1974).

The State Standard Organization of the USSR has confirmed a special State standard for the unit of neutron flux density in measurements relating to nuclear-physics installations. This standard constitutes a complex of measuring devices including sources of thermal and 14.5-MeV neutrons based on a modernized NG-160 neutron generator, a set of neutron-activated substances for determining the characteristics of the neutron fields in these sources, apparatus for measuring the induced activities of the standard samples, and also apparatus for recording the alpha particles accompanying the reactions involved in the production of 14.5-MeV neutrons. The basic standard ensures the reproduction of the unit of neutron flux density for thermal and 14.5-MeV neutrons in the flux-density range 10^2-10^7 neutrons/(cm · sec). The random error in the reproduction of the unit of neutron flux density, expressed in the form of the mean square deviation of the results of the measurements, is no greater than 0.3–0.5%; the residual systematic error is 0.5–0.7%. The development of the foregoing standard may be regarded as the first step in the creation of a standard basis for neutron measurements in nuclear-physics installations. At the same time as the basic standard the following All-Union State Standard (No. 8.105–74) has been confirmed: "State Measuring System. Special State Standard and All-Union certification procedure for devices measuring neutron flux density in nuclear-physics installations." (auth)

4298 THEORY OF OMEGA-D MODES. Asahi, Y. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). J. Nucl. Sci. Technol. (Tokyo); 12: No. 2, 92-106(Feb 1975).

A theory is presented on the omega-d modes which are eigenfunctions of a particular type of neutron diffusion operator. First, a general discussion is given on the implicit eigenvalue problem, reality, boundedness and distribution of the eigenvalues, order of magnitude and closure of the eigenfunctions. It is shown that the regular and adjoint eigenvalue problems reduce to an identical implicit eigenvalue problem. No one has in the past explicitly shown that the eigenvalue is real. The large variation in the order of magnitude of the eigenfunctions gives rise to a large variation in the mode coupling. This implies existence of weakly coupled modes that can be ignored. Next, these properties are verified for a symmetric reflected slab reactor by numerical calculations. The results disprove the conjecture advanced by others that the neutron fluxes associated with a particular cluster of seven modes are approximately the same. Finally, an equation is derived for the mode amplitudes which takes into account temperature feedback and external disturbance. Discussions are also given on the choice of appropriate modes for describing various kinds of dynamical processes. (auth)

4299 NEUTRON TRANSPORT PROBLEMS IN A SPHERICAL SHELL. Sahni, D. C. (Bhabha Atomic Research Centre, Bombay). J. Math. Phys. (N. Y.); 16: No. 11, 2260-2270(Nov 1975).

The density transform method was extended to cover spherically symmetric transport problems in a spherical shell. The density transform is expanded in plane geometry normal modes and explicit singular integral equations are derived for the expansion coefficients. It is shown that the Green's function method, introduced by Case et al., gives the same representation of total flux. The singular integral equations for the expansion coefficients are rederived using the analytic properties of some sectionally holomorphic functions introduced previously. (auth)

4300 INVARIANT IMBEDDING AND THE FREDHOLM INTEGRAL EQUATION. Wang, A. P. (Arizona State Univ., Tempe). J. Math. Phys. (N. Y.); 16: No. 11, 2207-2209(Nov 1975).

The standard method of solving the Fredholm integral equation is either to use Neumann series or to convert to an equivalent algebraic equation via the eigenvalues. An idea is used similar to that given by Ueno and others. The integral equation is transformed into a Cauchy problem which can be approximated effectively by modern high speed digital computer. (auth)

Nuclear Properties and Reactions, A ≤ 5

Refer also to abstracts 4245 and 4347.

4301 (CONF-750827-1) NEUTRON SCATTERING STUDY OF LIQUID ^{3}He. Skold, K.; Pelizzari, C.; Kleb, B.; Ostroski, G.; Rowe, J. M. (Argonne National Lab., Ill. (USA)). Aug 1975. 8p. Dep. NTIS $4.00.

From 14th international conference on low temperature physics; Otaniemi, Finland (14 Aug 1975).

A study of thermal excitations in liquid ^{3}He via the inelastic scattering of neutrons is reported. Preliminary results clearly indicate that reliable scattering functions can be obtained. (3 figures) (SDF)

4302 (LA-6041-T) PROTON–PROTON ANALYZING POWER MEASUREMENTS AT 16 MeV. Lovoi, P. A. (Los Alamos Scientific Lab., N. Mex. (USA)). Jul 1975. Contract W-7405-eng-36. 100p. Dep. NTIS $5.45.

Thesis.

Few attempts have been made to measure accurately the proton-proton analyzing powers at low energies. With the advent of polarized particle beams the measurement can now be made with high accuracy. Analyzing powers were measured at nine scattering angles from 10^0 to 35^0 in the laboratory system. As a check on systematic errors, analyzing power measurements were also made by scattering protons from ^{4}He. In the p Vector-p case the measured values are in very good agreement with the phase shift predictions. The p Vector-^{4}He measurements, while giving the same form and sign as the phase shift predictions, differ from the predictions by as much as 11 standard deviations. The p Vector-p analyzing powers had a maximum value of -0.0043 +- 0.0004 at 10^0 (laboratory) and decreased to zero near 25^0. A new technique to measure analyzing powers without symmetric detectors is explained. This technique preserves the advantages of the symmetric arm method in that current integration, target density, detector efficiencies, and geometry are cancelled from the final expressions. A new scattering chamber, named the Supercube, is described. The Supercube was designed primarily to perform scattering experiments with a polarized beam. It contains both left-right and up-down detectors for use with both spin-1/2 and spin-1 measurements. The Supercube was designed to make analyzing power measurements to an accuracy of 0.001 routine. The Supercube has proved to have low systematic errors and to perform as expected. The systematic errors were found to be equal to or less than 0.0002. (23 figures, 14 tables) (auth)

4303 (LA-UR-75-1416) DEUTERON D-STATE FROM THREE BODY STUDIES. Gibbs, W. R. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-eng-36. 13p. (CONF-750829-6). Dep. NTIS $4.00.

From 4th international symposium on polarization phenomena in nuclear reactions; Zurich, Switzerland (25 Aug 1975).

A brief history of the deuteron wave function is given to provide a background for a discussion of recent developments in knowledge of the deuteron D state. Techniques for measuring the percent D state in nucleon interactions with deuterium are described along with the motivation for attempting such measurements. (10 figures, 41 references) (SDF)

4304 (LA-UR-1447) R-MATRIX ANALYSIS. Dodder, D. C. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-eng-36. 7p. (CONF-750829-7). Dep. NTIS $4.00.

From 4th international symposium on polarization phenomena in nuclear reactions; Zurich, Switzerland (25 Aug 1975).

Scattering and reaction processes involving very few nucleons are studied via the R matrix formalism of Wigner and Eisenbud. As examples, the d + ^{3}He, p + ^{4}He, ^{3}He + ^{4}He, and p + ^{6}Li are considered. (3 figures) (SDF)

4305 (LBL-4000, pp 59-60) POLARIZATION EFFECTS IN THE NUCLEON–DEUTERON BREAKUP REACTION. Conzett, H. F. (Univ. of Basel); Rad, F. N.; Roy, R.; Birchall, J. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4306 (NP-20604) NEUTRON-NEUTRON FINAL STATE INTERACTIONS. (A Study of ND → NNP Above 100). Onel, Y. H. (Queen Mary Coll., London (UK)). Jun 1975. 152p. Dep. NTIS (US Sales Only) $10.75.

The reaction n + d → n + n + p has been studied in a kinematical region where very little interference is expected between processes giving a strong n-n final state interaction and those responsible for nn and np quasi-free scattering. Kinematically complete data have been obtained over a range of incident neutron energies from 100 to 155 MeV. A scintillating target of deuterated cyclohexane (C_6D_{12}) has been used. The two final state neutrons have been detected in coincidence with the proton recoiling in the target. The neutrons were detected in plastic scintillation counters close to the forward direction, these counters being set one behind the other so that the two neutrons detected were essentially colinear. Absolute differential cross sections have been extracted as a function of one of the final state neutron energies for incident energies between 100 and 155 MeV. A simple model based on Watson-Migdal theory for the final state interaction was used to fit the data obtained in this experiment and a value extracted for the neutron-neutron scattering length: $a_{nn} = -11^{+5}_{-5}$ fm. (auth)

4307 RESONATING-GROUP CALCULATION OF n+^{3}H SCATTERING. LeMere, M.; Brown, R.E.; Tang, Y.C.; Thompson, D.R. (School of Physics, University of Minnesota, Minneapolis, Minnesota 55455). Phys. Rev. C 12: No. 4, 1140-1145 (Oct 1975).

The single-channel resonating-group method with a central nucleon-nucleon potential is used to study the n+^{3}H system up to a c.m. energy of about 17 MeV. The specific distortion of the triton in this system is investigated, and it is found that its effect on the n+^{3}H phase shifts is small. A phenomenological imaginary potential is included in the calculation in order to account approximately for the effects of reactions on the elastic channel. The strength of this potential is chosen to reproduce measured total reaction cross sections for the charge-conjugate system p+^{3}He. The results of the calculation are in satisfactory agreement with measured n+^{3}H elastic differential cross sections. (auth)

4308 NUMERICAL INVESTIGATION OF MINIMAL THREE-BODY EQUATIONS. Amado, R.D.; Takahashi, T. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19174). Phys. Rev. C 12: No. 4, 1134-1139 (Oct 1975).

We compare numerical solution of the "minimal" three-body equations obtained from unitarity and analyticity with the full Schrödinger solution in a simple three-boson model. We find that for short-range forces the minimal equations give the correct shape, but not magnitude, for the three-body amplitudes. This is true even for a singular form with no mathematical credentials. (auth)

4309 ELECTRODISINTEGRATION OF ^{3}He. Kan, P.T.; Peterson, G.A.; Webb, D.V.; Szalata, Z.M. (Department of Physics and Astronomy, University of Massachusetts, Amherst, Massachusetts 01002); O'Connell, J.S.; Fivozinsky, S.P.; Lightbody, J.W. Jr.; Penner, S. Phys. Rev. C 12: No. 4, 1118-1125 (Oct 1975).

The continuum spectra of ^{3}He have been measured up to excitation energies of 40 MeV by means of inelastic electron scattering. Incident electron beam energies between 60 and 120 MeV were used, corresponding to a momentum transfer range of 0.3 fm^{-1} to 1.1 fm^{-1}. Scattered electrons were observed at two angles, 92.6° and 127.7°. The radiation corrected spectra and the form factors are presented, and compared with calculations based on a zero-range approximation. In this model, the sharp rise from the $p+d$ threshold previously reported may be identified as a $^2S \rightarrow ^2S$ Coulomb monopole transition. (auth)

4310 METHOD FOR THREE-BODY EQUATIONS. Adhikari, S.K.; Sloan, I.H. (School of Mathematics, The University of New South Wales, Kensington, New South Wales, 2033 Australia). Phys. Rev. C 12: No. 4, 1152-1157 (Oct 1975).

A recently proposed degenerate-kernel scheme for solving Fredholm integral equations of the second kind gave very good results for Lippmann-Schwinger equations. The method is here extended to give a very simple and practical method for the three-body equations with separable two-body interactions. Numerical calculations of the three-body amplitudes are carried out at positive energies for two simple models. In spite of the more complicated singularities in the kernel as well as in the solutions of the equation, satisfactory convergence is achieved. (auth)

4311 ELASTIC n-d SCATTERING WITH THE REID INTERACTION. Stolk, C.; Tjon, J.A. (Institute for Theoretical Physics, University of Utrecht, Utrecht, The Netherlands). Phys. Rev. Lett. 35: No. 15, 985-988 (13 Oct 1975).

For the case of the Reid soft-core potential the elastic neutron-deuteron scattering is studied. The three-nucleon equations are solved exactly for the pure s-wave parts of the two-nucleon T matrix while the higher partial-wave components of the force are treated perturbatively. Results are presented at 14.1 and 46.3 MeV. In particular, it is found that the pronounced minimum in the elastic cross section at higher energies, calculated with pure s-wave interactions, is filled in predominantly by the d-wave component of the deuteron. (auth)

4312 $\alpha+\alpha$ REACTION AND THE ORIGIN OF ^{7}Li. King, C.H.; Rossner, H.H.; Austin, S.M.; Chein, W.S. (Cyclotron Laboratory and Physics Department, Michigan State University, East Lansing, Michigan 48824); Mathews, G.J.; Viola, V.E. Jr.; Clark, R.G. Phys. Rev. Lett. 35: No. 15, 988-991 (13 Oct 1975).

Cross sections are presented for the production of ^{7}Li and ^{7}Be in the $\alpha+\alpha$ reaction between threshold and 140 MeV. Implications of these measurements for the problem of the origin of ^{7}Li in the universe are discussed. (auth)

4313 MOMENTUM-CUTOFF SENSITIVITY IN FADDEEV CALCULATIONS OF TRINUCLEON PROPERTIES. Brandenburg, R.A. (Institute of Theoretical Physics, University of Hannover, Hannover, Germany); Kim, Y.E.; Tubis, A. Phys. Rev. C 12: No. 4, 1368-1370 (Oct 1975).

By increasing the cutoff q_{max} from 1.7 fm^{-1} to a value $\gtrsim$ 2.8 fm^{-1} in momentum-space Faddeev calculations, we eliminate several discrepancies previously existing between momentum- and coordinate-space Faddeev calculations of trinucleon properties. (auth)

4314 ROLE OF THE NEUTRON CHARGE FORM FACTOR IN ELECTRON SCATTERING FROM THE THREE-NUCLEON SYSTEM. Brandenburg, R.A.; Sauer, P.U. (Institut für Theoretische Physik, Technische Universität Hannover, 3000 Hannover, West Germany). Phys. Rev. C 12: No. 4, 1101-1102 (Oct 1975).

We investigate the effects which the experimental uncertainty of the neutron charge form factor can have on the charge form factors of ^{3}H and ^{3}He. (auth)

4315 PHOTODISINTEGRATION OF THE DEUTERON. Chetovani, L. (Inst. d'Etudes Nucleaires, Algiers); Hammann, T. F.; Desgrolard, P. Nuovo Cim.; 28A: No. 4, 444-454(21 Aug 1975).

An analytical calculation of the total cross section of the ^{2}H(γ,p)n reaction E_γ < 30 MeV is presented using two realistic nonlocal separable N-N potentials. Exact analytical forms are given for all needed expressions. The results are in satisfactory agreement with the experimental data. The experimental cross section of the inverse process for thermal neutrons is reproduced within (3 to 5)% accuracy. The results are found to be potential dependent. (auth)

4316 ANALYSIS OF THE QUASI-FREE SCATTERING ^{2}H(p,2p)n USING REALISTIC POTENTIALS. Issa, A.; Durand, M. (Institut des Sciences Nucleaires, Grenoble, France). Lett. Nuovo Cim.; 14: No. 7, 245-249(18 Oct 1975).

Some quasi-free or nearly quasi-free scatterings are analyzed for incident proton between 60 and 160 MeV using realistic potentials to represent the two-body interaction. Near the quasi-free scattering one can calculate the first order single scattering term with the best potential and evaluate the following orders as corrections. The cross sections are found as a function of emergent proton energy. (JFP)

4317 INVESTIGATION OF THE REACTION d(e,e'p)n. Antuf'ev, Yu. P.; Agranovich, V. L.; Kuzmenko, V. S.; Sorokin, P. V. (Physical-Technical Inst., Moscow). Yadern. Fiz.; 22: No. 2, 236-241(Aug 1975). (In Russian)

Reaction d(e,e'p)n is investigated with registration of coincidences between the scattered electron and the knocked-out proton.

Magnetic spectrometers, scintillator counters and rapid electronics, including time-amplitude convertors, were used. The angular distribution of protons at the incident electron energy of 1195 MeV has been measured enabling one to obtain the momentum distribution of nucleons inside the deuteron in the momentum range from 0 up to 185 MeV/c. Dependences of the d(e,e'p)n reaction cross section on the knocked-out proton energy and on the polar angle of the neutron emission are also measured at the electron energies of 816 and 1195 MeV. The latter experiment enables on to test applicability of the plane-wave impulse approximation to describe the reaction at the neutron recoil momenta less than 100 MeV/c in a model-independent way. (5 figures) (auth)

4318 OFF-SHELL AND MULTIPLE SCATTERING EFFECTS IN THE $p+{}^2H \rightarrow 2p+n$ REACTION AT 156 MeV. L'Huillier, M.; Benoist-Gueutal, P.; Ballot, J.L. (Institut de Physique Nucléaire, Division de Physique Théorique, 91406 Orsay, France). Phys. Rev. C 12: No. 3, 948-962 (Sept 1975).

The nucleon-deuteron breakup reaction is analyzed in the framework of a model of single and double scattering using the off-shell t-matrix elements corresponding to several realistic local two-nucleon potentials. The multiple scattering contributions are estimated through a model derived from a fixed scattering centers approximation with a simple separable two-body t matrix. (auth)

4319 MEASUREMENT OF THE $^2H(p,n)$ pp TRANSVERSE POLARIZATION TRANSFER COEFFICIENT AT 20.4 MeV. Graves, R.G.; Jain, M.; Knox, H.D.; Chamberlin, E.P.; Northcliffe, L.C. (Cyclotron Institute, Texas A&M University, College Station, Texas 77843). Phys. Rev. Lett. 35: No. 14, 917-920 (6 Oct 1975).

The transverse polarization transfer coefficient, K_y', has been measured for the reaction $^2H(p,n)$ pp at 18° for E_p=20.4 MeV as a function of neutron energy. Although predictions based on a three-body separable-potential model with S-wave N-N interactions are in reasonable agreement with the data, the need for a three-body theory with more realistic N-N forces is indicated. (auth)

4320 SEARCH FOR TWO-PHOTON DECAY IN THERMAL np CAPTURE. Earle, E.D.; McDonald, A.B.; Häusser, O.; Lone, M.A. (Atomic Energy of Canada Limited, Chalk River Nuclear Laboratories, Chalk River, Ontario, Canada K0J 1J0). Phys. Rev. Lett. 35: No. 14, 908-910 (6 Oct 1975).

An upper limit of 10^{-4} has been obtained for the branching ratio for the emission of two photons ($E_\gamma > 0.57$ MeV) following thermal neutron capture in hydrogen. This limit was obtained with two Ge(Li) detectors shielded so as to reduce γ-ray scattering from one detector into the other and is a factor of 10 lower than has been recently reported. (auth)

4321 COMMENTS ON THE OBSERVATION OF TWO-PHOTON DECAY IN n-p CAPTURE. Alburger, D.E. (Centre de Recherches Nucléaires et Université Louis Pasteur, Strasbourg, France). Phys. Rev. Lett. 35: No. 12, 813-815 (22 Sept 1975).

Two-photon decay in n-p capture has been reported as having a branching ratio of 10^{-3} relative to single 2.23-MeV γ-ray emission. It is suggested that this result can be explained by crosstalk effects between detectors due to single γ rays, principally that associated with annihilation in flight following pair production. The shape of the observed γ-γ coincidence spectrum is consistent with this type of crosstalk and the apparent two-photon branch is about what is expected from a rough calculation of the magnitude of the crosstalk effect. (auth)

4322 OPTICAL-MODEL ANALYSIS OF N+C AND C+C ELASTIC SCATTERING. Eck, J.S.; Johnson, J.H.; Elliott, D.O.; Thompson, W.J. (Department of Physics, Kansas State University, Manhattan, Kansas 66506). Phys. Rev. Lett. 35: No. 14, 973-976 (6 Oct 1975).

Additional data and optical-model calculations for $^{14}N+^{12}C$ elastic scattering which expand and fortify the recently published optical-model analysis of N+C and C+C elastic scattering by Delic are discussed. (auth)

4323 ROLE OF PION RESCATTERING AND NUCLEON EXCHANGE IN THE FINAL STATE IN THE (π^-, nn) REACTION. Kopaleishvili, T.I.; Machabeli, I.Z.; Chakhunasvili, M.Sh. (Tbilisi State University). JETP Lett. 21: No. 10, 288-290 (20 May 1975).

Using ^{4}He as an example, it is shown that in the reaction (π^-, nn) the pion rescattering effect plays a decisive role at small momentum transfers, while the effective exchange between all nucleons in the final state plays a major role at large transfers. This leads to the appearance of corresponding two maxima, in agreement with the recently obtained experimental data.[10] (auth)

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Refer also to abstracts 4104, 4360, 4365, 4372, 4382, 4478, and 4479.

4324 (IKF-34, pp 3-4) HEAVY-ION REACTIONS BELOW THE COULOMB BARRIER. Bass, R.; Czarnecki, J. V.; Hartmann, V.; Rauch, F.; Zitzmann, R. (Univ., Franfurt am Main). 1974. (In German).

In annual report, 1974. (Frankfurt Univ. (F. R. Germany). Inst. fuer Kernphysik).

4325 (LBL-4000, pp 77-79) ENERGY VARIATION OF MULTINUCLEON TRANSFER REACTIONS WITH HEAVY IONS. Scott, D. K. (Hahn-Meitner Institut, Berlin); Hendrie, D. L.; Jahnke, U.; Kraus, L.; Maguire, C. F.; Mahoney, J.; Terrien, Y.; Yagi, K. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4326 (LBL-4000, pp 83-84) ^{7}Li + ^{7}Li REACTION STUDIES LEADING TO MULTI-NEUTRON FINAL STAGES. Cerny, J. (Univ. of Oxford); Weisenmiller, R. B.; Jelley, N. A.; Wilcox, K. H.; Wozniak, G. J. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4327 (LBL-4000, pp 84-85) STUDY OF T = 2 STATES IN ^{12}C AND ^{12}B. Ashery, D. (Tel-Aviv Univ., Israel); Goth, G. W.; Wozniak, G. J.; Zisman, M. S.; Cerny, J. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4328 (LBL-4000, pp 86) IS (α,^{8}Be) A DIRECT REACTION AT HIGH ENERGIES. Jelley, N. A. (Nuclear Structure Lab., Oxford); Wozniak, G. J.; Cerny, J. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4329 (LBL-4000, pp 87-88) α-TRANSFER STUDIES VIA THE (α,^{8}Be) REACTION ON ^{15}N AND ^{14}N. Wozniak, G. J. (Nuclear Structure Lab., Oxford); Jelley, N. A.; Cerny, J.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4330 (LBL-4000, pp 89-92) SPECTROSCOPIC STUDIES IN THE 1p-SHELL BY THE (^{6}Li,^{8}B) REACTION. Weisenmiller, R. B. (Nuclear Structure Lab., Oxford); Wilcox, K. H.; Jelley, N. A.; Wozniak, G. J.; Ashery, D.; Cerny, J. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4331 (LBL-4000, pp 124-126) EXCITATION FUNCTIONS FOR SIMPLE PION INDUCED NUCLEAR REACTIONS ON ^{14}N, ^{16}O AND ^{19}F. Jacob, N. P. Jr.; Markowitz, S. S. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4332 (NP-20526, pp 23-24) ^{12}C(^{6}He,^{3}He)^{12}C AND ^{12}C(^{3}He, ^{4}He)^{11}C REACTIONS AT 82.1 MeV. Koyama, K.; Tanabe, T.; Yasue, M.; Yokomizo, H.; Sato, K.; Kohame, J.; Koori, N.; Tanaka, S. 1974.

In Institute for Nuclear Study Annual Report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

4333 (NP-20526, pp 24-26) REACTION ^{12}C(^{3}He,d)^{13}N AT 81.4 MeV. Koyama, K.; Yokomizo, H.; Tanaka, M.; Hasegawa, T.; Takeuchi, S.; Toba, T.; Goto, A. 1974.

In Institute for Nuclear Study annual report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

4334 (NP-20526, pp 26-27) STUDY OF ^{12}C(^{6}He,^{7}Be)^{8}Be REACTION AT 82 MeV. Kato, S.; Kubono, S.; Tanaka, M. 1974.

In Institute for Nuclear Study annual report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

4335 (NP-20526, pp 28-29) STUDY OF THE REACTIONS ^{14}N(p,t)^{12}N and ^{14}N(p,^{3}He)^{12}C. Tanabe, T.; Yasue, M.; Koyama, K.; Soga, F.; Yokomizo, H.; Ohnuma, H.; Matsuki, S.; Ogino, K. 1974.

In Institute for Nuclear Study annual report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

4336 (NP-20526, pp 29-30) MULTINUCLEON TRANSFER REACTIONS OF THE TYPE (p,^{8}Li) and (p,^{7}Be) AT 51.9 MeV. Yamaya, T. (Tohoku Univ., Sendai); Endo, H.; Takimoto, K.; Fujii, K.; Shimizu, J.; Hatanaka, K.; Kasagi, J.; Takahashi, N.; Iwasaki, Y.; Kato, S.; Kubono, S. 1974.

In Institute for Nuclear Study annual report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

4337 (NP-20526, pp 128) ^{7}Be PRODUCTION FROM PROTON BOMBARDMENT OF BORON. 1974.

In Institute for Nuclear Study annual report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

4338 RADIATIVE DECAY OF THE SECOND EXCITED STATE OF ^{12}C. Mak, H.; Evans, H.C.; Ewan, G.T. (Queen's University, Kingston, Ontario, Canada); McDonald, A.B.; Alexander, T.K. Phys. Rev. C 12: No. 4, 1158-1166 (Oct 1975).

The branching ratio Γ_{rad}/Γ for the electromagnetic decay of the 7.655 MeV second excited state of ^{12}C has been measured by detecting the ^{12}C (0.0 MeV) recoils in coincidence with α particles from the $^{13}C(^3He,\alpha_2)^{12}C$ (7.655 MeV) reaction at $E_{^3He}$ = 4.00 MeV. Coincidence events were identified by means of time-of-flight, energy, and kinematic constraints. Thus, of all the ^{12}C nuclei formed in the second excited state, only those decaying to the ^{12}C ground state by either γ-ray or positron-electron pair emission were selected. Hence the experiment provides a direct measurement of Γ_{rad}/Γ, where $\Gamma_{rad}=\Gamma_\gamma+\Gamma_{e+e}$, and gives $\Gamma_{rad}/\Gamma = (4.15\pm0.34)\times10^{-4}$, which is in good agreement with other recent measurements, and suggests that the previously accepted value of $\Gamma_{rad}/\Gamma = (2.9\pm0.3)\times10^{-4}$ may be too low. The significance of this result is discussed with respect to helium burning rates in stars. (auth)

4339 PROTON TOTAL REACTION CROSS SECTIONS FOR THE DOUBLY MAGIC NUCLEI ^{16}O, ^{40}Ca, AND ^{208}Pb IN THE ENERGY RANGE 20-50 MeV. Carlson, R.F.; Cox, A.J.; Nimmo, J.R. (Department of Physics, University of Redlands, Redlands, California 92373); Davison, N.E.; Elbakr, S.A.; Horton, J.L.; Houdayer, A.; Sourkes, A.M.; van Oers, W.T.H.; Margaziotis, D.J. Phys. Rev. C 12: No. 4, 1167-1175 (Oct 1975).

Proton total reaction cross sections have been measured for the doubly magic nuclei ^{16}O, ^{40}Ca, and ^{208}Pb in the energy range 20-50 MeV. For the $p+^{16}O$ system, total reaction cross sections were measured in 400 keV steps over practically the entire energy range. The $p+^{40}Ca$ and $p+^{208}Pb$ total reaction cross sections were measured at six and nine different energies, respectively. The experimental total reaction cross sections are compared with results based on optical model analyses in which preliminary data from the present experiment were included. An evaluation of the imaginary potential parameters is reported. Using the proton total reaction cross section information for ^{16}O, ^{40}Ca, and ^{208}Pb available in the literature, general characteristics of these cross sections in the energy range 10-1000 MeV are shown. A comparison has been made between the measured total reaction cross sections and those predicted by global optical model parameter sets. (auth)

4340 $^{10}B(^7Li,p)^{16}N$ AND J^π OF $^{16}N(3.520)$. Fortune, H.T.; Medsker, L.R. (Physics Department, University of Pennsylvania, Philadelphia, Pennsylvania 19174). Phys. Rev. C 12: No. 4, 1364-1365 (Oct 1975).

Results of the $^{10}B(^7Li,p)^{16}N$ reaction suggest $J=2$ if the 3.520-MeV "level" is a single state and $J=0$ and 1 if it is an unresolved doublet. (auth)

4341 CONFIRMATION OF THE PREDICTED L DEPENDENCE IN THE RADIAL FORM FACTOR FOR NUCLEUS-NUCLEUS INELASTIC SCATTERING. Moffa, P.J.; Vary, J.P.; Dover, C.B. (Brookhaven National Laboratory, Upton, New York 11973); Towsley, C.W.; Hanus, R.G.; Nagatani, K. Phys. Rev. Lett. 35: No. 15, 992-995 (13 Oct 1975).

The multipolarity (L) dependence of the inelastic form factor for heavy-ion-induced excitations predicted by the folding model is confirmed in the analysis of the scattering of ^{14}N from ^{12}C and ^{16}O at 155 MeV. Agreement between the target deformation lengths ($\beta_L R_i$) of these measurements and those from electromagnetic and proton experiments is found when the strongly L-dependent folding-model form factor is employed. (auth)

4342 MEASUREMENT OF SMALL-ANGLE HADRON--CARBON ELASTIC SCATTERING AMPLITUDES AND K/sub S/ REGENERATION AMPLITUDE. Hakel, W. J. Rochester, NY; Univ. of Rochester (1975). 270p. University Microfilms Order No. 75-15,204.

Thesis (Ph. D.).

Total nuclear cross sections sigma/sub T/ were determined by means of transmission measurements for pi^+, pi^-, K^+, K^-, p, and anti p incident on carbon at 2.01 GeV/c. Measurements of sigma /sub T/ for K^+, K^- on carbon were repeated at 1.68 and 2.26 GeV/c. In a second, related experiment differential elastic scattering cross section distributions were measured in the nuclear-Coulomb interference region (q^2 less than or equal to .025 $(GeV/c)^2$) for the same set of incident particles and momenta. A wire-plane spark chamber spectrometer using magnetostrictive readout was employed in both experiments to record particle trajectories and provide momentum analysis information. Imaginary parts of the nuclear forward elastic scattering amplitudes f^{+-}/sub N/(0) were obtained directly from the measured total cross sections for each particle-antiparticle pair by means of the optical theorem: f^{+-}/sub N/(0) equals (k/4pi) sigma/sub T/ (+-). Fits to the diffractive scattering distributions provided values for Re f^{+-}/sub N/(0) and the nuclear slope parameter b. The result of the analysis of the two coupled experiments was a complete specification of f^{+-}/sub N/(q^2) equals f^{+-}/sub N/(0) e/sup -(h/2)q^2/ for each incident particle and momentum. The principle of charge symmetry provides a test of the analysis procedure for pi^+ and pi^-. Within experimental error one obtains f^+/sub N/(q^2) equals f^-/sub N/(q^2) in agreement with the prediction of charge symmetry. Finally, the three pairs of K^{+-}-carbon amplitudes f^{+-}/sub N/(0) were used to predict the K/sub S/ regeneration amplitude and phase in carbon at 1.68, 2.01, and 2.26 GeV/c. (Diss. Abstr. Int., B)

4343 SCATTERING OF 14.1 MeV NEUTRONS BY ^6Li, ^7Li, ^9Be, ^{10}B AND ^{11}B. Hyakutake, M.; Sonoda, M.; Katase, A.; Wakuta, Y.; Matoba, M. (Kyushu Univ., Fukuoka (Japan). Faculty of Engineering). J. Nucl. Sci. Technol. (Tokyo); 11: No. 10, 407-421(Oct 1974).

Using a time-of-flight spectrometer, the differential cross sections were measured for the elastic and inelastic scattering of 14.1-MeV neutrons by ^6Li, ^7Li, ^9Be, ^{10}B and ^{11}B. In the case of elastic scattering by ^7Li and ^{10}B, correction was applied to subtract the contribution of inelastic scattering from the unresolved first excited state, after which, the elastic scattering data were compared with predictions based on the optical model. The potential parameters derived with a seven-parameter search yielded angular distributions agreeing with the present experimental data. The expressions for these parameters are presented as a function of mass number. The experimental data on inelastic scattering were analyzed with the distorted wave Born approximation. The deformation parameters were estimated to be nearly equal to or larger than unity for these nuclei. (auth)

4344 THE MULTI-STEP PROCESS IN THE $^{12}C(^3He,\alpha)^{11}C$ REACTION. Yamaji, S.; Fujisawa, T.; Kamitsubo, H.; Matsuda, K.; Motonaga, S. (Institute of Physical and Chemical Research, Wako, Saitama (Japan)). J. Phys. Soc. Jpn.; 37: No. 5, 1191-1195(Nov 1974).

The reaction $^{12}C(^3He,\alpha)^{11}C$ was studied at the bombarding energies of 24.0, 29.2, 34.7 and 39.6 MeV and differential cross sections were analyzed in DWBA and CCBA. The large strength of shell-model-forbidden transition of the $5/2^-$ state was found to be well explained by the multi-step processes including inelastic channels. (auth)

4345 $^{11}B(p,\alpha)^8Be(\alpha)^4He$ REACTION AT 7.3 MeV. Kakigi, S.; Fukunaga, K. (Kyoto Univ., Uji (Japan). Inst. for Chemical Research); Fujiwara, N.; Ohsawa, T.; Nguyen, D. C. Bull. Inst. Chem. Res., Kyoto Univ.; 52: No. 1, 218-226(Jul 1974).

Angular distributions of the first emitted alpha particles and angular correlations between the first and the second emitted alpha particles were measured. These angular distributions and correlations were analyzed on the basis of the compound nucleus process. The spin of 2 is assigned favorably to the compound nuclear state of ^{12}C formed in the reaction. (auth)

4346 INELASTIC SCATTERING OF NEGATIVE PIONS ON C^{12} UNDER DISTORTED WAVE IMPULSE APPROXIMATION. Nishiyama, T. (Osaka Univ., Toyonaka (Japan). Faculty of Engineering Science). Prog. Theor. Phys. (Kyoto); 52: No. 3, 952-970(Sep 1974).

Inelastic scattering of negative pions on C^{12} is investigated in the distorted wave impulse approximation. Cross sections are calculated for excitations of 2^+(4.43 MeV), 3^-(9.64 MeV) and of complex levels around 15 MeV by pions with energies from 120 to 280 MeV, and are compared with experiments. (auth)

4347 (d,n) REACTIONS ON ^2H, ^6Li, ^7Li, ^9Be, AND ^{12}C NUCLEI Azimov, S. A.; Arifkhanov, U. R.; Gulyamov, M.; Islamov, B. I.; Iskhakov, T.; Mukhamedzhanov, A. M.; Ergashov, E.; Faizullaev, U. I.; Yarmukhamedov, R. (Inst. of Nuclear Physics, Tashkent). Yadern. Fiz.; 22: No. 2, 225-235(Aug 1975). (In Russian)

The cyclotron beam of the Uzbek Nuclear Physics Institute was used to measure by the time-of-flight method the neutron spectra and the differential cross sections of the (d,n) reaction on the nuclei ^2H, ^6Li, ^7Li, ^9Be, and ^{12}C at the deuteron energies of 13.9 and 15.25 MeV. The differential cross sections were compared with the distorted waves calculations in order to obtain the values of the spectroscopic factors. The experimental angular distributions are compared with the results of the peripheral model. The values of the coupling constants G_p^2 are evaluated. (5 figures, 3 tables) (auth)

4348 HIGH α CLUSTER STATES IN THE ^{20}Ne NUCLEI. Artemov, K. P.; Gol'dberg, V. Z.; Petrov, I. P.; Serikov, I. N.; Rudakov, V. P.; Timofeev, V. A.; Wolski, R.; Szmider, J. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 22: No. 2, 242-250 (Aug 1975). (In Russian)

The angular $d\sigma_0$ correlation in the process $^{16}O(^6Li,d)^{20}Ne^*(\alpha)^{16}O_{(g.s.)}$ is measured at 35.3 MeV energy of the ^6Li ions. It is found that in the ^{20}Ne nucleus at 19–23 MeV excitation energy there are groups of states having obvious α cluster features. Spin, parities and reduced α widths of those states are determined. (3 figures, 1 table) (auth)

4349 INVESTIGATION OF THE REACTION $\mu^- {}^{12}C \rightarrow {}^4He^4He^3H\nu\nu$. Batusov, Yu. A.; Bunyatov, S. A.; Vizireva, L.; Gulkanyan, G. R.; Mirsalikhova, F.; Sidorov, V. M.; Chernev, Kh. M.; Eramzhyan, R. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 22: No. 2, 320-327(Aug 1975). (In Russian)

The reaction $\mu^-{}^{12}C \rightarrow {}^4He^4He^3H\nu\nu$ is investigated. An upper bound to its relative probability is established: $W \lesssim 2.10^{-2}$. Possible mechanisms of the reaction are considered; it is shown that with the relative probability of $(1.1 \pm 0.1) \cdot 10^{-2}$ per capture event, it proceeds according to the scheme, predicted with the resonance mechanism of the μ^--meson capture by the carbon nucleus. (5 figures) (auth)

4350 INDUCED WEAK CURRENTS AND β^+-α ANGULAR CORRELATIONS IN $A=8$. Tribble, R.E.; Garvey, G.T. (Joseph Henry Laboratories, Princeton University, Princeton, New Jersey 08540). Phys. Rev. C 12: No. 3, 967-983 (Sept 1975).

β-α angular correlations of the form $\omega(\theta_{\beta\alpha}) = 1 + a\cos^2\theta_{\beta\alpha} + p\cos^2\theta_{\beta\alpha}$ have been measured as a function of β energy for the two decays $^8Li \rightarrow {}^8Be \rightarrow 2\alpha$ and $^8B \rightarrow {}^8Be \rightarrow 2\alpha$. The results of the angular correlations are considered in a model independent analysis, along with a comparison to model dependent wave function calculations. The a coefficient is a kinematic term that depends on $\langle 1/v^n \rangle$, where v^n is the center of mass velocity of the α particle. A detailed comparison between the experimental results and the theoretical prediction for a shows that the measured kinematic term is (10–15%) smaller than the prediction. The p coefficients arise from induced weak currents. Utilizing the G-parity properties of these currents, we discuss the results corresponding to $\delta_\pm = p_{^8Li} \pm p_{^8B}$. The second order β energy dependence in $\delta-$ is found to be negligible. Assuming no second order energy dependence, the experimental result is $(\delta_-)\ m_\nu/E_\beta = 7.0 \pm 0.5 = (b/Ac) - (d_{II}/Ac)$, where b and d_{II} are the weak magnetism and second class currents, and c is the Gamow-Teller current. The experimental result for $(\delta_+)\ m_\nu/E_\beta$ determines the first class induced tensor current d_I, and the second forbidden axial currents j_2 and j_3. The interpretation of $(\delta_+)\ m_\nu/E_\beta$ is complicated since wave function predictions indicate that all three currents should contribute significantly to δ_+. (auth)

4351 MEASUREMENT OF THE ENERGY OF THE 6129-keV γ RAY OF ^{16}O. Shera, E.B. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). Phys. Rev. C 12: No. 3, 1003-1005 (Sept 1975).

The precise isotopic mass-difference values of Smith and Wapstra have been used as a reference in the determination of the energy of the 6129-keV γ ray of ^{16}O. This transition is widely used as an energy standard in nuclear spectroscopy and in muonic x-ray studies. The value of the γ-ray energy was found to be 6129.170±0.043 keV. The quoted uncertainty is approximately one order of magnitude smaller than that of previous determinations. Data from the measurements also indicate that the new and highly precise mass values form a self-consistent set. (auth)

4352 CASCADE PROCESS IN MUON CAPTURE AND GAMMA-NEUTRINO ANGULAR CORRELATIONS. Devanathan, V. (Department of Nuclear Physics, University of Madras, Madras 600 025, India); Subramanian, P.R. Ann. Phys. (N.Y.) 92: No. 1, 25-43 (July 1975).

A nuclear cascade process resulting from muon capture and subsequent deexcitation by gamma emission is considered. Possible observable quantities such as the final nuclear polarization and the gamma-neutrino angular correlation coefficients are investigated. It is shown that the nuclear transition with the spin sequence $0 \rightarrow J_f \rightarrow 0$ is very favorable for study since the angular correlation coefficients in this case are not affected by the uncertainties in the gamma decay matrix elements. For a more restricted transition with $J_f = 1$, there exist some simple relations connecting the asymmetry coefficient of the recoil nucleus emitting the gamma ray and the gamma-neutrino angular correlation coefficients. These relations are shown to be independent of both the nuclear structure and the muon capture coupling constants. Numerical results are presented for the nuclear transition $^{16}O(0^+, g.s.) \xrightarrow{E_\gamma} {}^{16}N(1^-, 392\ KeV) \rightarrow {}^{16}N(0^-, 120\ KeV)$. (auth)

4353 UNSURPRISING ASPECTS OF HEAVY-ION—INDUCED TWO-NUCLEON TRANSFER REACTIONS. Nair, K.G.; Towsley, C.W.; Hanus, R.; Hamm, M.; Nagatani, K. (Cyclotron Institute, Texas A&M University, College Station, Texas 77843). Phys. Rev. Lett. 35: No. 13, 838-841 (29 Sept 1975).

An apparent puzzle concerning the suppression of heavy-ion—induced nn and pp transfers compared to np transfer in light nuclei can be explained to a great extent by invoking simple arguments based on the binding energies of the transferred pairs to the two cores. The manifestation of this effect is in the tail regions of the appropriate bound-state wave functions where transfer is well known to occur. These arguments may be extended to include multinucleon transfers where the consequences of this effect could be even more drastic. (auth)

4354 SHAPE PARALLELISM OF THE LOWEST PROTON RESONANCE IN $^{12}C(p,p)$ AND IN $^{12}C(d,n)$. Bommer, J.; Ekpo, M.; Fuchs, H.; Grabisch, K.; Kluge, H. (Hahn-Meitner-Institut für Kernforschung Berlin GmbH, Bereich Kern- und Strahlenphysik, Berlin, Germany and Fachbereich Physik der Freien Universität Berlin, Berlin-West, Germany). Phys. Rev. C 12: No. 3, 1069-1071 (Sept 1975).

The shape of the lowest $^{12}C+p$ resonance has been studied in a high-resolution $^{12}C(d,n)^{13}N$ measurement. The shape displays a pronounced asymmetry, in quantitative agreement with a corresponding observation in elastic proton scattering. (auth)

4355 STRUCTURE IN THE ENERGY DEPENDENCE OF THE PROTON TOTAL REACTION CROSS SECTION FOR C AND Si IN THE ENERGY REGION 20–40 MeV. Šlaus, I. (Institute Ruder Bošković, Zagreb, Yugoslavia); Margaziotis, D.J.; Carlson, R.F.; van Oers, W.T.H.; Richardson, J.R. Phys. Rev. C 12: No. 3, 1093-1095 (Sept 1975).

Measurements of proton total reaction cross sections for ^9Be, ^{12}C, ^{16}O, and ^{28}Si have been made in the energy range between 20–44 MeV. The cross sections show irregular energy variation for ^{12}C at about 23.8 and 25.9 MeV, and for ^{28}Si at 30.3 and 33.5 MeV; irregularities were not observed clearly for ^9Be or ^{16}O. (auth)

4356 EVIDENCE FOR THE ISOSCALAR GIANT QUADRUPOLE RESONANCE IN ^{16}O. Knöpfle, K.T.; Wagner, G.J.; Breuer, H. (Max-Planck-Institut für Kernphysik, D-69 Heidelberg, Germany); Rogge, M.; Mayer-Böricke, C. Phys. Rev. Lett. 35: No. 12, 779-782 (22 Sept 1975).

The spectra of 146-MeV α particles scattered inelastically from ^{16}O exhibit a giant-resonance-type structure excitation energies of 15.9 and 27.3 MeV. The analysis of angular distributions shows its quadrupole nature and yields a strength exhausting about 65% of the isoscalar E2 energy-weighted sum rule. (auth)

4357 γ-RAY DECAY OF THE 9.042 AND 9.806 MeV STATES IN ^{23}Na. Green, P.W.; Jones, G.D.; Kelly, D.T.; Kuehner, J.A.; Petty, D.T. (Tandem Accelerator Laboratory, McMaster University, Hamilton, Ontario, Canada L8S 4K1). Phys. Rev. C 12: No. 3, 887-893 (Sept 1975).

The $^{12}C(^{12}C,p\gamma)^{23}Na$ reaction, at an incident energy of $E_{c.m.} = 19.3$ MeV, has been used to study the γ-ray decay of the 9.042 and 9.806 MeV levels in ^{23}Na, which are resonantly excited at this energy. Doppler shift attenuation measurements have yielded liftetime limits of $\tau < 10$ fs for the 9.042 MeV level and $\tau < 20$ fs for the 9.806 MeV level. Angular distributions of the γ rays deexciting these two levels have been measured, and the results are consistent with the assumption of $J = 15/2$ and $J = 17/2$, respectively. The measurements indicate that these two levels are likely candidates for the $15/2^+$ and $17/2^+$ members of the ground state rotational band in ^{23}Na. (auth)

4358 EXCITATION OF GIANT MAGNETIC AND SPIN-ISOSPIN DIPOLE STATES IN RADIATIVE π CAPTURE ON ^{14}N AND ^{10}B. Baer, H.W.; Bistirlich, J.A.; de Botton, N.; Cooper, S.; Crowe, K.M. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720); Truöl, P.; Vergados, J.D. Phys. Rev. C 12: No. 3, 921-937 (Sept 1975).

The photon spectra in the capture of stopped pions on ^{14}N and ^{10}B were measured in the 50–150-MeV region with a high-resolution pair spectrometer. The total radiative capture branching ratios are 2.13 ± 0.21 and 2.27 ± 0.22%, respectively. The spectrum corresponding to the first 13 MeV excitation in each of the residual nuclei ^{14}C and ^{10}Be is dominated by the transition to the analog of a giant $M1$ state of the target nucleus. The ground state transitions in both nuclei are resolved experimentally. The measured branching ratio for the extremely weak ^{14}C(g.s.) transition is $(3 \pm 2) \times 10^{-5}$. There is evidence for selective excitation of the analogs of the giant diople spin-isospin states of ^{14}N, of which the 3^- component appears to be the strongest. In ^{10}B the transition strength to the giant resonance region is more fragmented. An analysis is presented that employs an impulse-approximation Hamiltonian with amplitudes taken directly from the fundamental process on the nucleon, $\pi^- + p \rightarrow n + \gamma$, and shell-model wave functions obtained using realistic interactions in the 1s, 1p, and 2s-1d shells. Also, a calculation for the ^{14}C(g.s.) transition from 1s capture using the "elementary-particle soft-pion" ansatz is presented. (auth)

4359 MULTINUCLEON REMOVAL INDUCED BY HIGH-ENERGY PROTONS. Artun, O.; Cassagnou, Y.; Legrain, R.; Lisbona, N.; Roussel, L. (Département de Physique Nucléaire, Centre d'Etudes Nucléaires de Saclay, 91190 Gif-sur-Yvette, France); Alard, J.P.; Baldit, A.; Costilhes, J.P.; Fargeix, J.; Roche, G.; Tamain, J.C. Phys. Rev. Lett. 35: No. 12, 773-775 (22 Sept 1975).

Various light- and medium-mass nuclei have been bombarded with 150-, 230-, 600-, and 960-MeV protons. Prompt γ rays were measured

with a Ge(Li) detector. A large number of lines in the γ-energy spectra correspond to the de-excitation of the first levels of 4*n* nuclei (N = Z even). The dependence of this effect on the incident energy and the mass of the target is studied. The data are compared with recent pion-bombardment results. (auth)

Nuclear Properties and Reactions, 20 ≤ A ≤ 38

Refer also to abstracts 4336, 4353, 4355, 4357, 4359, 4370, and 4382.

4360 (LBL-4000, pp 123-124) NUCLEAR REACTIONS OF C, Al, AND F WITH RELATIVISTIC HEAVY IONS AT THE BEVALAC. Murphy, D. L.; Markowitz, S. S. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4361 (NP-20526, pp 128) ^{32}Si PRODUCTION FROM PROTON BOMBARDMENT OF NaCl. 1974.

In Institute for Nuclear Study annual report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

4362 KILOVOLT ^{33}S(n,α_0) AND ^{33}S(n,γ) CROSS SECTIONS: IMPORTANCE IN THE NUCLEOSYNTHESIS OF THE RARE NUCLEUS ^{36}S. Auchampaugh, G.F. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544); Halperin, J.; Macklin, R.L.; Howard, W.M. Phys. Rev. C 12: No. 4, 1126-1133 (Oct 1975).

The ^{33}S(n,α_0) and ^{33}S(n,γ) cross sections have been measured from ~10 to ~700 keV. Resonance parameters are given for 39 resonances. The level spacing is determined to be 9.1±0.9 keV. The σ (n,α_0) and σ (n,γ) cross sections are averaged over a Maxwellian distribution for values of kT from 25 to 275 keV. When these cross sections are used in a nucleosynthesis calculation of the rare isotope ^{36}S, the overproduction of this isotope, relative to the other nuclei formed in the universe, is reduced from a factor of 10 to 2.5. (auth)

4363 ^{37}Cl($p,^3$He)^{35}S REACTION. Guichard, A.; Nann, H.; Wildenthal, B.H. (Cyclotron Laboratory, Michigan State University, East Lansing, Michigan 48824). Phys. Rev. C 12: No. 4, 1109-1117 (Oct 1975).

Angular distributions of the ^{37}Cl($p,^3$He)^{35}S reaction at 40.2 MeV bombarding energy have been measured for states in ^{35}S up to 9.16 MeV energy excitation. These data have been analyzed with the distorted-wave Born approximation, and values of the angular momentum L transferred to several states have been deduced. A shell-model analysis of the transitions to the low-lying levels has been performed, and the new information gained about the structure of ^{35}S is discussed. (auth)

4364 $E0$ DECAY OF THE FIRST EXCITED 0$^+$ STATES IN ^{34}S AND ^{38}Ar. Souw, K.H.; Adloff, J.C.; Disdier, D.; Chevallier, P. (Centre de Recherches Nucléaires, Université Louis Pasteur, Strasbourg, France). Phys. Rev. C 12: No. 4, 1103-1108 (Oct 1975).

The reactions ^{31}P(α,p)^{34}S and ^{35}Cl(α,p)^{38}Ar have been used to study the $E0$ π decays of the ^{34}S(3.91 MeV,0$^+$) and ^{38}Ar(3.38 MeV,0$^+$) states to the ground state. The $E0$ branching ratios Γ_π/Γ were measured to be (0.38±0.06) ×10^{-3} and (6.6±1.0) ×10^{-3}, respectively. When these values are combined with the available lifetimes of these states, $E0$ matrix elements $\langle M\rangle_\pi$ = (1.55±0.15) fm^2 (^{34}S) and (2.26±0.21) fm^2 (^{38}Ar) are obtained. (auth)

4365 POPULATION OF HIGH-SPIN STATES IN ^{23}Na THROUGH THE ^{11}B(^{16}O, α) REACTION. del Campo, J.G. (Instituto de Fisica, Universidad de Mexico, Mexico 20 D. F., Mexico); Gustafson, D.E.; Robinson, R.L.; Stelson, P.H.; Miller, P.D.; Bair, J.K.; McGrory, J.B. Phys. Rev. C 12: No. 4, 1247-1259 (Oct 1975).

States in ^{23}Na were populated with the ^{11}B(^{16}O, α) reaction. Energy-averaged differential cross sections were measured in the energy range $E_{c.m.}$ = 16.9-18.5 MeV for 29 excited states in ^{23}Na from 0 to 15 MeV of excitation, and for the laboratory angles 7, 15, 25, and 150°. Single energy differential cross sections were measured for laboratory angles of 40, 55, and 70° at a bombarding energy of 43.2 MeV. The experimental angular distributions were compared with Hauser-Feshbach calculations, and good agreement was found for the states of known spin values in ^{23}Na. Candidates for high-spin states in ^{23}Na were selected for the ground-state rotational band, and for the $K=1/2^+$ and $K=1/2^-$ bands. The reliability of using Hauser-Feshbach calculations for spin assignments is discussed, and a comparison of the suggested excitation energies for high-spin states with shell-model calculations is presented. (auth)

4366 OPTICAL MODEL PARAMETERS OF SEVERAL s-d SHELL NUCLEI FOR 28 MeV ALPHA-PARTICLE SCATTERING. Kokame, J. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study). Bull. Inst. Chem. Res., Kyoto Univ.; 52: No. 1, 227-232(Jul 1974).

Optical model parameters of Mg, Si, S, and Ar for alpha particle elastic scattering ($E_\alpha \cong$ 28 MeV) are calculated by the DWBA method using an automatic search program. For S and Ar, the values of real potential obtained are about 90 and 75 MeV, respectively. They are deeper than those of Mg and Si which are about 56 and 52 MeV, respectively. (auth)

4367 PRODUCTION CROSS SECTIONS FOR ^{7}Be AND ^{22}Na IN TARGETS OF Si, Mg, Fe, AND Ni IRRADIATED BY 1, 2, 3, AND 23 GeV PROTONS. Raisbeck, G.M.; Yiou, F. (Laboratoire René Bernas du Centre de Spectrometrie Nucleaire et de Spectrometrie de Masse, 91406 Orsay, France). Phys. Rev. C 12: No. 3, 915-920 (Sept 1975).

Production cross sections for ^{7}Be and ^{22}Na have been measured by direct γ counting of targets of Si, Mg, Fe, and Ni irradiated by protons of 1, 2, 3, and 23 GeV. In essentially all cases significant differences are found with previously reported values. The results are also compared with a recent semiempirical formula. (auth)

Nuclear Properties and Reactions, 39 ≤ A ≤ 58

Refer also to abstracts 4339, 4359, 4366, and 4367.

4368 (AECD/MISC-4, pp 33-36; 53-56) ANALOGUE RESONANCES IN ^{56}Fe BY (p,γ) AND (p,n) REACTIONS ON ^{55}Mn. Ahmed, N. (Atomic Energy Center, Dacca, Bangladesh); Rahman, M. A.; Khatun, S.; Awal, M. A.; Rahman, M.; Sen Gupta, H. M. Dec 1974.

In annual technical report, July 1972-June 1973. (Atomic Energy Center, Dacca (Bangladesh)).

4369 (AECD/MISC-4, pp 40; 41; 61-63) ANALOGUE RESONANCES IN ^{58}Co. Ahmed, N. (Atomic Energy Center, Dacca, Bangladesh); Rahman, M. A.; Khatun, S.; Awal, M. A.; Rahman, M.; Sen Gupta, H. M. Dec 1974.

In annual technical report, July 1972-June 1973. (Atomic Energy Center, Dacca (Bangladesh)).

4370 (IKF-34, pp 7-8) STUDY OF THE ELECTROMAGNETIC TRANSITIONS IN THE NUCLEUS ^{39}K. Bass, R.; Lorz, H.; Weber, T. (Univ., Frankfurt am Main). 1974. (In German).

In annual report, 1974. (Frankfurt Univ. (F. R. Germany). Inst. fuer Kernphysik).

4371 (LBL-4000, pp 67-70) TWO PROTON TRANSFER ON ^{54}Fe STUDIED WITH HIGH ENERGY HEAVY ION REACTIONS (^{16}O,^{14}C) AND (^{12}C,^{10}Be). Homeyer, H. (Hahn-Meitner Institut, Berlin); Becchetti, F. D.; Harvey, B. G.; Hendrie, D. L.; Kover, D. G.; Mahoney, J.; von Oertzen, W. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4372 (LBL-4067) EFFECT OF FREE-PARTICLE COLLISIONS IN HIGH ENERGY PROTON AND PION-INDUCED NUCLEAR REACTIONS. Jacob, N. P. Jr. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1975. Contract W-7405-ENG-48. 185p. Dep. NTIS $12.25.

Thesis.

The effect of free-particle collisions in simple "knockout" reactions of the form (a,aN) and in more complex nuclear reactions of the form (a,X) was investigated by using protons and pions. Cross sections for the ^{49}Ti(p,2p)^{47}Sc and the ^{74}Ge(p,2p)^{73}Ga reactions were measured from 0,3 to 4,6 GeV incident energy. The results indicate a rise in (p,2p) cross section for each reaction of about (25 +- 3) percent between the energies 0,3 and 1,0 GeV, and are correlated to a large increase in the total free-particle pp scattering cross sections over the same energy region. Results are compared to previous (p,2p) excitation functions in the GeV energy region and to (p,2p) cross section calculations based on a Monte Carlo intranuclear cascade-evaporation model. Cross section measurements for (pi/sup +-/, piN) and other more complex pion-induced spallation reactions were measured for the light target nuclei ^{14}N, ^{16}O, and ^{19}F from 45 to 550 MeV incident pion energy. These measurements indicate a broad peak in the excitation functions for both (pi,pi N) and (pi,X) reactions near 180 MeV incident energy. This corresponds to the large resonances observed in the free-particle pi$^+$p and pi$^-$p cross sections at the same energy. Striking differences in (pi,pi N) cross section magnitudes are observed among the light nuclei targets. The experimental cross section ratio sigma(pi$^-$,pi$^-$n)/sigma(pi$^+$,pi N) at 180 MeV is 1,7 +- 0,2 for all three targets. The experimental results are compared to previous pion and analogous proton-induced reactions, to Monte Carlo intranuclear cascade-evaporation calcula-

tions, and to a semi-classical nucleon charge exchange model. (108 references) (auth)

4373 (NP-20526, pp 30-32) STUDY OF THE REACTION ^{40}Ca(p,d)^{39}Ca AT 52 MeV. Kubono, S.; Kato, S.; Yasue, M.; Ohuma, H.; Sasao, M.; Tsukamoto, K.; Kuramasu, R. 1974.

In Institute for Nuclear Study annual report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

4374 LIFETIME MEASUREMENTS AND DEFORMED STATES IN ^{41}Ca. Tabor, S.L.; Young, K.C. Jr.; Balamuth, D.P.; Zurmühle, R.W. (Physics Department, University of Pennsylvania, Philadelphia, Pennsylvania 19174). Phys. Rev. C 12: No. 4, 1212-1226 (Oct 1975).

The Doppler-shift attenuation method has been applied to measure the mean lives of levels in ^{41}Ca. States were populated using the ^{40}Ca(d,p)^{41}Ca reaction at E_d=3 MeV and protons emerging from the reaction were detected near 180° relative to the beam. γ rays were detected in coincidence with the protons using a 65 cm^3 Ge(Li) detector placed successively at angles of 53°, 90°, and 140°. Values or limits were obtained for the lifetimes of 39 levels in ^{41}Ca. There is a serious disagreement between some of the lifetime values measured in the present experiment and those reported in a previous work. Accurate excitation energies and the decay scheme were also determined. Information from the lifetimes and decay scheme has been used to make spin assignments or restrictions to a number of levels in ^{41}Ca. The electromagnetic transition strengths determined from the present lifetime measurements and a previous measurement of γ-ray angular correlations have been compared to the predictions of two models of the negative parity spectrum of ^{41}Ca. In addition, an interpretation of part of the positive parity spectrum has been developed using the strong-coupling model. This calculation includes the effects of the Coriolis term in the Hamiltonian which mixes rotational bands, and the calculated excitation energies, transition rates, and pickup spectroscopic factors have been compared with experiment. (auth)

4375 SPIN EFFECTS IN THE SCATTERING OF 1-GeV PROTONS BY NUCLEI. Kujawski, E. (Department of Physics, Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213); Vary, J.P. Phys. Rev. C 12: No. 4, 1271-1277 (Oct 1975).

The elastic scattering of 1-GeV protons by ^{58}Ni and ^{208}Pb is analyzed using the first-order optical potential including the spin-orbit term. These potentials are generated using realistic nucleon-nucleon scattering amplitudes and nuclear densities with full isospin dependence maintained. The sensitivity of the differential cross sections and polarizations to the spin-orbit potentials and nuclear densities is investigated. (auth)

4376 GENERALIZED PAIRING IN N=Z EVEN-EVEN 2p-1f SHELL NUCLEI. Sandhu, T.S.; Rustgi, M.L. (Physics Department, State University of New York, Buffalo, New York 14214); Goodman, A.L. Phys. Rev. C 12: No. 4, 1340-1345 (Oct 1975).

Hartree-Fock-Bogoliubov calculations have been performed for self-conjugate even-even nuclei in the 2p-1f shell using the central Yukawa interaction and Kuo-Brown reaction matrix elements for the Hamada-Johnston potential. The possibility of generalized pairing correlations is studied by considering T=0, T=1, and T=0+T=1 correlations and comparing the ground-state properties for axial and triaxial shapes. It is found that for nuclei studied neither the correlations T=0 nor T=1 play any important role in the ground state. In general T=0+T=1 pairing yields results which are identical with those obtained with either T=0 or T=1. In the excited states, however, the T=0 correlations are found to be more important than the T=1 correlations. (auth)

4377 PREDOMINANCE OF THE DIRECT REACTION MODE IN ^{58}Ni(^{6}Li,d)^{62}Zn. Jundt, F.; Coffin, J.P.; Fulbright, H.W.; Guillaume, G. (Laboratorie de Physique Nucléaire et d'Instrumentation Nucléaire, Centre de Recherches Nucléaires et Université Louis Pasteur, Strasbourg, France). Phys. Rev. C 12: No. 4, 1366-1367 (Oct 1975).

Measurements of the angular distribution of deuterons from the ^{58}Ni(^{6}Li,d)^{62}Zn reaction have been extended to large angles. A decrease of about two orders of magnitude is seen between 30 and 170°, in general agreement with distorted-wave Born-approximation (DWBA) predictions. The case for using simple DWBA analysis to extract α particle spectroscopic factors is thus strengthened. (auth)

4378 g FACTOR OF THE 3.830 MeV (15/2$^+$) LEVEL IN ^{41}Ca. Young, L.E.; Sprouse, G.D.; Strottman, D. (Department of Physics, State University of New York, Stony Brook, New York 11794). Phys. Rev. C 12: No. 4, 1358-1359 (Oct 1975).

The g factor of the 3.830 MeV level of ^{41}Ca has been measured by the time-differential perturbed-angular-distribution method to be $g=+0.29\pm0.02$. The reaction ^{27}Al(^{16}O, p, n)^{41}Ca was used to populate the state in a magnetic field of 58 kG. The measured g factor can be understood within the configuration $(d_{3/2}{}^{-1}\ f_{7/2}{}^2)^{15/2+}$. The calculated g factor depends sensitively on the isospin character of the particle-hole interaction. (auth)

4379 FORBIDDEN TRANSITIONS IN THE ^{48}Ca(d,p)^{49}Ca REACTION. Metz, W.D.; Callender, W.D.; Bockelman, C.K. (Wright Nuclear Structure Laboratory, Yale University, New Haven, Connecticut 06520). Phys. Rev. C 12: No. 3, 827-844 (Sept 1975).

In a measurement of the angular distribution of proton groups from the ^{48}Ca(d,p)^{49}Ca reaction at E_d=20 MeV, particular emphasis is placed on the observation of seven weak transitions to states below 5 MeV excitation. These distributions are analyzed using distorted-wave Born-approximation (DWBA) parameters fixed by fitting, at E_d=13.0, 16.0, and 19.3 MeV, the angular distributions of the elastically scattered deuterons and the protons populating the single-particle $2p_{3/2}$, $2p_{1/2}$, and $1f_{5/2}$ states. The DWBA model also fits the (d,p) data of other investigators at E_d=7.0 and 10.0 MeV. The same model is then applied to the seven weak transitions, for which earlier data are available at 7.5 and 10.0 MeV in addition to the new E_d=20 MeV data. New partial angular distributions at 9.0 MeV are helpful in resolving some discrepancies. For three of the weak transitions, older l assignments are confirmed, for two of them new l assignments are made, and for two transitions the observed behavior is incompatible with any reasonable DWBA model. All seven transitions can be explained as populating 2p-1h states formed by coupling a neutron to excited states of the ^{48}Ca core. (auth)

4380 LIFETIMES OF THE 6_1^+ STATES IN ^{42}Ti AND ^{46}Ca AND $E2$ EFFECTIVE CHARGES IN $(1f_{7/2})^{*2}$ NUCLEI. Kutschera, W.; Brown, B.A.; Ikezoe, H.; Sprouse, G.D.; Yamazaki, Y.; Yoshida, Y. (Department of Physics, University of Tokyo, Bunkyo-ku, Tokyo, Japan); Nomura, T.; Ohnuma, H. Phys. Rev. C 12: No. 3, 813-820 (Sept 1975)

The mean lifetimes of the 6^+_1 states in ^{42}Ti at 3041 keV and ^{46}Ca at 2974 keV have been measured with the pulsed beam method to be $\tau = 5 \pm 2$ ns and 15.2 ± 0.8 ns, respectively. The states were populated via the reactions ^{40}Ca(^{3}He,n)^{42}Ti at $E_{^3He}$ = 12 MeV and ^{44}Ca($\alpha,\alpha 2n$)^{46}Ca at E_α=50 MeV. The deduced B ($E2$, $6^+ \rightarrow 4^+$) values result in proton and neutron effective charges which are in good agreement with other $(1f_{7/2})^{*2}$ nuclei. However, the present lifetime result for ^{42}Ti is in disagreement with another measurement for this nucleus. A comparison of $E2$ effective charges extracted from all presently available B ($E2$) data on the $6^+ \rightarrow 4^+ \rightarrow 2^+ \rightarrow 0^+$ transitions in $(1f_{7/2})^{*2}$ nuclei is presented. (auth)

4381 SHELL STRUCTURE OF THE ^{58}Ni CHARGE DENSITY. Sick, I. (Department of Physics, University of Basel, Basel, Switzerland); Bellicard, J.B.; Bernheim, M.; Frois, B.; Huet, M.; Leconte, Ph.; Mougey, J.; Xuan-Ho, P.; Royer, D.; Turck, S. Phys. Rev. Lett. 35: No. 14, 910-913 (6 Oct 1975).

A very-high momentum-transfer (q=780 MeV/c), elastic electron-scattering experiment on ^{58}Ni has been performed using the 600-MeV linac of Saclay. The charge density, extracted from (e,e) and muonic-x-ray data, exhibits considerably less structure than predicted by Hartree-Fock calculations. (auth)

4382 FORE-AFT ANISOTROPY IN THE RADIATIVE CAPTURE OF 14-MeV NEUTRONS. Arthur, E.D.; Drake, D.M. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545); Halpern, I. Phys. Rev. Lett. 35: No. 14, 914-917 (6 Oct 1975).

Relative yields of capture photons have been observed for four nuclei at angles of 55°, 90°, and 125° in bombardments with 14-MeV neutrons. The yields from ^{10}B, ^{29}Si, and ^{40}Ca show smaller fore-aft anisotropies than those observed in corresponding proton captures. This suggests that the forward peaking in (p,γ) reactions is due mainly to direct rather than collective capture amplitudes. Photons from ^{12}C(n,γ_0)^{13}C peak backward, but this peaking cannot be straightforwardly accounted for in terms of the interference between the collective excitations dominant in this energy region. (auth)

4383 TEST OF SCALE INVARIANCE IN RATIOS OF MUON SCATTERING CROSS SECTIONS AT 150 AND 56 GeV. Watanabe, Y.; Hand, L.N.; Herb, S.; Russell, A. (Laboratory of Nuclear Studies, Cornell University, Ithaca, New York 14853); Chang, C.; Chen, K.W.; Fox, D.J.; Kotlewski, A.; Kunz, P.F.; Loken, S.C.; Strovink, M.; Vernon, W. Phys. Rev. Lett. 35: No. 14, 898-901 (6 Oct 1975).

Scale invariance is tested in ratios of muon scattering cross sections from an iron target at pairs of q^2 values ranging to 40 (GeV/c)^2 and differing by a factor of 3/8. The apparatus was changed with incident energy to preserve acceptance and resolution in scaled variables. The scale-noninvariant departure from unity of these ratios displays a statistically significant ω dependence. The effect exceeds the systematic uncertainty by a factor of 1.7. (auth)

4384 OBSERVED DEVIATIONS FROM SCALE INVARIANCE IN HIGH-ENERGY MUON SCATTERING. Chang, C.; Chen, K.W.; Fox, D.J.; Kotlewski, A.; Kunz, P.F. (Physics Department, Michigan State University, East Lansing, Michigan 48824); Hand, L.N.; Herb, S.; Russell, A.; Watanabe, Y.; Loken, S.C.; Strovink, M.; Vernon, W. Phys. Rev. Lett. 35: No. 14, 901-904 (6 Oct 1975).

Scale noninvariance is observed in 150- and 56-GeV muon scattering from an iron target. In the range $1 < q^2 < 40$(GeV/c)^2, νW_2 rises with q^2

at fixed $\omega' \gtrsim 6$ and falls at $\omega' \lesssim 6$. The scale breaking is statistically and systematically significant, and persists with alternative choices of scaling variable. It is parametrized roughly by a constant $b = \partial^2 \ln(\nu W_2)/\partial \ln(\omega') \partial \ln(q^2)$ with a value near 0.09. (auth)

4385 RELATIVE SIZES OF ^{40,48}Ca FROM THE SCATTERING OF 79 MeV α PARTICLES. Lerner, G.M.; Hiebert, J.C.; Rutledge, L.L. Jr. (Cyclotron Institute and Physics Department, Texas A&M University, College Station, Texas 77843); Papanicolas, C.; Bernstein, A.M. Phys. Rev. C 12: No. 3, 778-794 (Sept 1975).

The scattering of 79.1 MeV α particles from ^{40,48}Ca has been measured with high relative accuracy and analyzed with a folding model for the optical potential. The result for ΔR, the difference between the ^{40,48}Ca rms matter radii, is $\Delta R = 0.05 \pm 0.04$ fm. This result appears smaller than most previous measurements which employed Woods-Saxon potentials or diffraction analyses. Most of the discrepancies are removed when the definition of the matter radius used in each analysis is scrutinized. Combining ΔR with the results of electromagnetic experiments yields the relative neutron-proton radius difference in ^{48}Ca; $R_n(48) - R_p(48) = 0.03 \pm 0.08$ fm. These results are compared with Hartree-Fock calculations which tend to produce larger differences. Possible reasons for this discrepancy are discussed. (auth)

4386 STUDY OF ^{48}V WITH THE ^{50}Cr(p,^{3}He) REACTION AT 44.7 MeV. Guichard, A.; Benenson, W.; Nann, H. (Cyclotron Laboratory and Physics Department, Michigan State University, East Lansing, Michigan 48824). Phys. Rev. C 12: No. 3, 806-812 (Sept 1975).

The ^{50}Cr(p,^{3}He)^{48}V reaction has been studied at 44.7 MeV for levels with an excitation energy up to 3.7 MeV. A distorted-wave Born approximation analysis permitted several L assignments. A comparison with available information on ^{48}V is made. (auth)

Nuclear Properties and Reactions, 59 ≤ A ≤ 89

Refer also to abstracts 4049, 4367, 4372, and 4376.

4387 (AECD/MISC-4, pp 37-39; 57-60) ANALOGUE RESONANCES IN ^{60}Ni. Ahmed, N. (Atomic Energy Center, Dacca, Bangladesh); Rahman, M. A.; Khatun, S.; Awal, M. A.; Rahman, M.; Sen Gupta, H. M. Dec 1974.

In annual technical report, July 1972–June 1973. (Atomic Energy Center, Dacca (Bangladesh)).

4388 (IKF-34, pp 10-15) γ DECAY OF THE $d_{\frac{5}{2}}$ ANALOG STATES IN ^{89}Zr AND ^{89}Y. Proepper, U.; Rauch, F.; Nottrodt, H. P. (Univ., Frankfurt am Main). 1974. (In German).

In annual report, 1974. (Frankfurt Univ. (F. R. Germany). Inst. fuer Kernphysik).

4389 (LBL-4000, pp 35-39) INTERPRETATIONS OF LINE STRUCTURE IN DELAYED-NEUTRON SPECTRA. Shihab-Eldin, A. A. (Univ. of California, Berkeley); Nuh, F. M.; Prussin, S. G.; Franz, H.; Kratz, J. V.; Kratz, K. L.; Rudolph, W.; Herrmann, G. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4390 (LBL-4000, pp 103) PARTICLES EMITTED IN THE INTERACTION OF Cu WITH ^{20}Ne AT 252-MeV BOMBARDING ENERGY. Jared, R.; Moretto, L. G.; Babinet, R.; Galin, J.; Hunter, J.; Schmitt, R.; Moulton, J.; Thompson, S. G. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4391 (NP-20526, pp 33-34) LIFETIME OF ^{62}Ga SUPER-ALLOWED β DECAY. Chiba, R. (Tokyo Inst. of Tech.). Shibasaki, S.; Numao, T.; Yokota, H.; Yamada, S.; Iritani, Y.; Kotajima, K.; Iwasaki, S. 1974.

In Institute for Nuclear Study annual report, January 1974–December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

4392 (NP-20526, pp 34-35) STRUCTURE OF ^{73}As. Hiratate, Y. (Tohoku Inst. of Tech., Sendai); Suehiro, T.; Miura, K.; Sholi, T.; Orihara, H.; Ishizaki, Y.; Yamaguchi, H. 1974.

In Institute for Nuclear Study annual report, January 1974–December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

4393 (NP-20526, pp 35-36) (p,p′) AND (p,t) REACTIONS OF 51.9 MeV PROTONS ON DOUBLY EVEN SELENIUM NUCLEI. Matoba, M. (Kyushu Univ., Fukuoka, Japan); Hyakutake, M.; Koori, N.; Irie, Y.; Tsuji, T.; Aoki, Y.; Rangacharhulu, C.; Murakami, H. 1974.

In Institute for Nuclear Study annual report, January 1974–December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

4394 MEAN LIFE AND COLLECTIVE EFFECTS OF THE 937 keV, 0$^+$ STATE IN ^{72}Se: EVIDENCE FOR NUCLEAR COEXISTENCE. Ramayya, A.V.; Ronningen, R.M.; Hamilton, J.H.; Pinkston, W.T.; Garcia-Bermudez, G. (Physics Department, Vanderbilt University, Nashville, Tennessee 37235); Robinson, R.L.; Kim, H.J.; Carter, H.K.; Collins, W.E. Phys. Rev. C 12: No. 4, 1360-1363 (Oct 1975).

The $0^{+\prime}$ state at 937 keV in ^{72}Se is unusual in that it is only 75 keV above the first excited 2^+ state. The half-life $T_{1/2}$ of the $0^{+\prime}$ state was determined to be 15.8 ± 0.9 nsec by delayed coincidence techniques. The ratio of the $E0/E2$ decays was measured to be 0.37 ± 0.23 and the reduced monopole matrix element ρ was calculated to be $0.176_{-0.070}^{+0.048}$. The B ($E2$) value of the 75-keV transition was deduced to be 36 ± 7 single-particle units. This large B ($E2$) value indicates that the $0^{+\prime}$ state is collective. These data are interpreted in terms of a coexistence of spherical and deformed shapes. (auth)

4395 EXCITATION FUNCTIONS FOR THE DEUTERON INDUCED REACTIONS ON ^{64}Zn AND ^{76}Ge. Nishi, T.; Fujiwara, I.; Imanishi, N.; Nakahara, H.; Okamoto, H. (Kyoto Univ., Uji (Japan). Inst. of Atomic Energy). Bull. Inst. Chem. Res., Kyoto Univ.; 52: No. 1, 233-239(Jul 1974).

The excitation functions of ^{64}Zn(d,p)^{65}Zn, ^{64}Zn(d,n)^{65}Ga, ^{64}Zn(d,2n)^{64}Ga, ^{64}Zn(d,α)^{62}Cu, ^{64}Zn(d,αn)^{61}Cu, ^{76}Ge(d,p)^{77}Ge, ^{76}Ge(d,n)^{77}As, ^{76}Ge(d,2n)^{76}As, ^{76}Ge(d,α)^{74}Ga, and ^{76}Ge(d,αn)^{73}Ga were studied with the radiochemical method. The experimental results were analyzed with modified Peaslee's theory. The ρ-values obtained by this analysis were compared with the previous results. (auth)

4396 LEPTON CONSERVATION IN THE DOUBLE β DECAY OF ^{82}Se. Cleveland, B.T.; Leo, W.R.; Wu, C.S.; Kasday, L.R.; Rushton, A.M. (Department of Physics, Columbia University, New York, New York 10027); Gollon, P.J.; Ullman, J.D. Phys. Rev. Lett. 35: No. 12, 757-760 (22 Sept 1975).

We report an experimental investigation of the lepton-nonconserving neutrinoless double β decay of ^{82}Se. The half-life of this decay mode is found to be greater than 3.1×10^{21} yr at a 68% confidence level. By use of the reported total lifetime of ^{82}Se obtained from recent mass-spectrometric measurements, an upper limit of 9% on the branching ratio for neutrinoless decay is estimated. This corresponds to an upper bound of $\sim 3 \times 10^{-4}$ for the lepton-nonconservation amplitude if a two-nucleon mechanism is assumed. (auth)

4397 APPLICATION OF THE BOSON-EXPANSION METHOD TO EVEN Se AND Ru ISOTOPES. Lie, S.G.; Holzwarth, G. (Physik-Department der Technischen Universität München, Theoretische Physik, 8046 Garching b. München, Federal Republic of Germany). Phys. Rev. C 12: No. 3, 1035-1053 (Sept 1975).

The expansion coefficients of a fourth-order collective Hamiltonian for the low-lying quadrupole vibrations are derived from the microscopic fermion Hamilton operator by a modified Marumori boson-expansion method. Their dependence on the phonon structure, on the parameters of the two-body (surface δ) interaction and on the single-particle energies is numerically investigated. For the isotopes ^{76}Se, ^{78}Se, and ^{100}Ru, ^{102}Ru the results are compared with coefficients that are obtained from phenomenological fits to low-lying levels. Quadrupole moments and B ($E2$) values are calculated in lowest order. (auth)

4398 THEORETICAL PREDICTIONS OF ELECTROMAGNETIC PROPERTIES OF $1g_{9/2}$ ODD-NEUTRON NUCLEI IN THE CORIOLIS COUPLING MODEL. Heller, S.L.; Friedman, J.N. (Mathematics Department of Physics, Staten Island Community College, Staten Island, New York 10301). Phys. Rev. C. 12: No. 3, 1006-1016 (Sept 1975).

Magnetic dipole and electric quadrupole moments and reduced transition rates of several $1g_{9/2}$ nuclei are calculated using the wave rates of several $1g_{9/2}$ nuclei are calculated using the wave functions generated in a previous paper. The pattern of wave functions is shown to support the application of a fixed parameter Coriolis coupling model to nuclei in this region. By a total inclusion of both diagonal and nondiagonal single-particle contributions, theoretical magnetic moments for ground and first excited states of both parities are brought into exceptional agreement with experiment. In particular, this analysis resolves the essential equality of μ (7/2) and μ (9/2) in ^{83}Kr as opposed to the expected equivalence of their g factors. Quadrupole moments, calculated without resorting to effective charges, are generally well predicted. Theoretical transition rates are calculated in two instances and agree with experiment. (auth)

Nuclear Properties and Reactions, 90 ≤ A ≤ 149

Refer also to abstracts 4389, 4397, and 4426.

4399 (IKF-34, pp 16-17) DETERMINATION OF ELECTROMAGNETIC TRANSITION MATRIX ELEMENTS IN ^{121,123}Sb. Sehrt, G.; Stelzer, K.; Rauch, F. (Univ., Frankfurt am Main). 1974. (In German).
In annual report, 1974. (Frankfurt Univ. (F. R. Germany). Inst. fuer Kernphysik).

4400 (LBL-4000, pp 70-71) STUDY OF THE ^{142}Nd(^{18}O,^{16}O)^{144}Nd REACTION. Yagi, K. (Osaka Univ.); Harvey, B.; Hendrie, D.; Jahnke, U.; Maguire, C.; Mahoney, J.; Scott, D. Jul 1975.
In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4401 (LBL-4000, pp 74-76) INTERFERENCE BETWEEN DIRECT AND INDIRECT MODES IN TWO-NUCLEON TRANSFER REACTIONS WITH HEAVY IONS. Harvey, B. G. (Hahn-Meitner Institut, Berlin); Hendrie, D. L.; Jahnke, U.; Kraus, L.; Maguire, C. F.; Mahoney, J.; Scott, D. K.; Terrien, Y.; Yagi, K.; Glendenning, N. K. Jul 1975.
In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4402 (LBL-4000, pp 104-106) STUDY OF THE RELAXATION PROCESSES IN THE REACTION BETWEEN ^{107,109}Ag AND ^{20}Ne AT 175 MeV AND 252 MeV. Babinet, R.; Galin, J.; Fowler, M.; Jared, R.; Hunter, J.; Moretto, L. G.; Thompson, S. G. Jul 1975.
In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4403 (LBL-4000, pp 106-107) STUDY OF THE FRAGMENTS EMITTED IN THE INTERACTION BETWEEN Ag AND ^{40}Ar AT 288-MeV AND 340-MeV BOMBARDING ENERGY. Galin, J.; Babinet, R.; Fowler, M.; Jared, R.; Gatti, R.; Thompson, S. G.; Moretto, L. G. Jul 1975.
In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4404 (NP-20526, pp 36-37) EXCITATION OF ISOBARIC ANALOG STATES IN THE (p,d) REACTIONS ON ^{95}Mo, ^{116}Sn, AND ^{118}Sn. Ishimatsu, T. (Tohoku Univ., Sendai); Hayashibe, S.; Kawamura, N.; Saito, H.; Awaya, T.; Ohmura, H. 1974.
In Institute for Nuclear Study annual report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

4405 (NP-20526, pp 37-38) ELECTRIC MONOPOLE TRANSITIONS BETWEEN 0^+ STATES IN ^{100}Ru. Koike, M.; Kawakami, H.; Komura, K.; Yamada, H. 1974.
In Institute for Nuclear Study annual report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

4406 (NP-20526, pp 39-41) ELASTIC AND INELASTIC SCATTERING OF 51.93 MeV PROTONS FROM ^{106}Pd, ^{108}Pd, AND ^{110}Pd. Koike, M.; Pingel, K.; Nonaka, I.; Wada, T.; Fujisawa, T.; Kamitsubo, H.; Suehiro, T.; Nojiri, T. 1974.
In Institute for Nuclear Study annual report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

4407 (NP-20526, pp 41-44) DEEPLY BOUND HOLE STATES AND ANALOG STATES OBSERVED BY NEUTRON PICKUP REACTIONS. Sekiguchi, M.; Sakai, M.; Shida, Y.; Soga, F.; Hirao, Y. 1974.
In Institute for Nuclear Study annual report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

4408 (NP-20526, pp 44-46) EXCITED 0^+ STATES E0 TRANSITIONS IN ^{118}Sn. Kawakami, H.; Yoshikawa, N.; Komura, K.; Koike, M.; Yamada, H. 1974.
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4409 (NP-20526, pp 46-47) QUASI-BANDS IN ^{124,126}Xe AND ^{132}Ba. Kusakari, H.; Yoshikawa, N.; Kawakami, H.; Shida, Y.; Sakai, M. 1974.
In Institute for Nuclear Study annual report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

4410 (NP-20526, pp 47-48) PENETRATION EFFECTS FOR INTERNAL CONVERSIONS IN ^{131}Cs. Hisatake, K.; Toriyama, T.; Morinaga, A.; Saito, T. (Tokyo Inst. of Tech.). 1974.
In Institute for Nuclear Study annual report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

4411 (NP-20526, pp 48-50) IN-BEAM γ-RAY STUDY OF ^{131}La. Nakayama, H. (Univ. of Tokyo); Chiba, J.; Sekimoto, M.; Hayano, R.; Hamagaki, H.; Nakai, K.; Yoshikawa, N.; Kawakami, H. 1974.
In Institute for Nuclear Study annual report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

4412 PROPERTIES OF HIGH-SPIN STATES IN ^{99}Tc FROM ^{93}Nb(α,2$n\gamma$)^{99}Tc* (γ) REACTION SPECTROMETRY: A TEST OF THE CLUSTER-CORE COUPLING MODEL. Sarantites, D.G. (Department of Chemistry, Washington University, St. Louis, Missouri 63130). Phys. Rev. C 12: No. 4, 1176-1204 (Oct 1975).
The structure and properties of the high angular momentum states in ^{99}Tc up to 5605 keV of excitation have been investigated via measurements of excitation functions of singles γ rays and of $\gamma\gamma$ coincidences following the ^{93}Nb(α, 2n)^{99}Tc *(γ) reaction with α particles energies between 17-30 MeV. From these experiments and from high-resolution singles energy, angular-distribution, and Doppler-shift attenuation measurements, the position and the decay properties of many high angular momentum states in ^{99}Tc have been determined. Levels at 626.82 $(5/2_1)^+$, 882.16 $(13/2_1)^+$, 927.78 $(3/2_1)^+$, 957.07 $(11/2_1)^+$, 1084.95 $(5/2_2^+, 7/2^+)$, 1178.60 $(7/2_2)^+$, 1214.53 $(9/2_1)^-$, 1307.19 $(11/2_2)^+$, 1514.8 $(17/2_1)^+$, 1549.4 $(15/2_1)^+$, and 1702.1 $(13/2_1)^-$ with the J^π values in parentheses are confirmed. New levels at 2119.4 $(15/2_1)^+$, 2183.2 $(19/2_1)^?$, 2231.1 $(17/2_2)^+$, 2546.4 $(21/2_1)^+$, 2846.7 $(21/2_2^+$ or $21/2_1^-)$, 2905.8 $(19/2_2)^+$, 3038.8 $(19/2_2^+, 17/2^+)$, 3515.2 $(25/2_1)^+$, 3657.7 $(25/2_2^+$ or $25/2_1^-)$, 3917.5 $(29/2_1)^+$, 4292.2 $(27/2_1)^+$, 4455.4 $(29/2_2^+$ or $29/2_1^-)$, 4761.0 (29/2, 33/2), and 5604.9 (33/2, 31/2) with the J^π values in parentheses are proposed. Possible levels at 2474.2, 3064.9, and 3209.2 $(21/2_3)^+$ keV are also suggested. The measured angular distributions provided (i) branching ratios, (ii) J^π assignments corroborated by deduced angular-distribution attenuation coefficients, level excitation functions, and side-feeding yields, and (iii) multipole mixing ratios δ ($E2/M1$). Lifetimes for nine high-spin levels and limits for four additional ones were obtained by the Doppler-shift attenuation method from measurements with the ^{93}Nb(α,2$n\gamma$)^{99}Tc* (γ) reaction at 18.5, 20.6, 23.6 and 26.7 MeV. The lifetimes were extracted from singles spectra taken in the presence of standards at 7, 4, 7, and 8 angles, respectively, between 0° and 90° for the four bombardment energies by examining the dependence on E_α of the effective level lifetime. For many transitions B (E2) and B ($M1$) values were obtained. The present results are compared with calculations based on the coupling of three-quasiparticle $(g_{9/2})^3$ configurations to the quadrupole vibrations of the core and remarkable agreement is observed for states up to only $19/2^+_1$. This model fails to explain the properties of the higher-spin states with $J^\pi \geq 21/2^+$. (auth)

4413 SYSTEMATIC STUDY OF THE STRUCTURE OF ODD-MASS LANTHANUM NUCLEI. I. LEVELS IN ^{137}La FROM ^{137}Ce^{m+g} DECAY. Henry, E.A.; Smith, N.; Johnson, P.G.; Meyer, R.A. (Lawrence Livermore Laboratory, Livermore, California 94550). Phys. Rev. C 12: No. 4, 1314-1320 (Oct 1975).
The level structure of ^{137}La populated by the β decay of ^{137}Ce^{m+g} was studied by γ-ray and conversion-electron spectroscopy using mass-separated sources, large-volume and Compton-suppressed Ge(Li) detectors, and a Si(Li) detector. Nine previously unreported transitions were observed and two more levels were established in ^{137}La. The ^{137}La level structure is discussed in terms of the weak-coupling model. (auth)

4414 SYSTEMATIC STUDY OF THE STRUCTURE OF ODD-MASS LANTHANUM NUCLEI. II. LEVELS IN ^{135}La FROM ^{135}Ce DECAY. Henry, E.A.; Meyer, R.A. (Lawrence Livermore Laboratory, Livermore, California 94550). Phys. Rev. C 12: No. 4, 1321-1335 (Oct 1975).
The β decay of 17.6-h ^{135}Ce to levels in ^{135}La was studied by γ-ray and conversion-electron spectroscopy, and by extensive γ-γ-coincidence experiments. The use of mass-separated sources, a Compton-suppressed spectrometer, and the megachannel analyzer system for coincidence studies has enabled substantial extension of the experimental knowledge of ^{135}La. Seventy-three previously unreported transitions were observed in the singles and coincidence data. Six levels not proposed in earlier works are firmly established here, and two other levels are tentatively proposed. The level structure of ^{135}La is compared to the systematics of related nuclei and to qualitative interpretations of nuclear models that attempt to describe this nucleus. (auth)

4415 PULSED BEAM MEASUREMENTS OF THE g-FACTORS OF THE ISOMERIC STATES IN ^{115}Sn AND ^{117}Sb. Ivanov, E. A.; Iordachescu, A.; Pascovici, G. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 20: No. 2, 141-156(1975).
The g-factors of the $11/2^-$, 159 μs and $1/2^+$, 3.26 μs states in ^{115}Sn and of the $25/2^+$, 340 μs state in ^{117}Sb were measured with the pulsed beam time-differential perturbed angular distribution method. The isomeric states were excited by (α,xn) reactions with a 24-MeV pulsed beam. The following results were obtained: $g(11/2^-, {}^{115}Sn) = -0.250(2)$, $g(1/2^+, {}^{115}Sn) = +0.195(3)$ and $g(25/2^+, {}^{117}Sb) = +0.121(3)$. The deviations of the experimental g-factors of the ground and isomeric states in ^{115}Sn from the theoretical values derived from the single-particle values corrected for the core polarization and two-body spin-orbit effects were analyzed in

terms of δg_1 and δg_s and the results $\delta g_1 = -0.077(4)$ and $\delta g_s = +0.3(2)$ for a neutron in ^{115}Sn were obtained. (auth)

4416 CALCULATION OF THE β-DECAY FEATURES OF NUCLEI IN THE VICINITY OF ^{124}Sb. Batkin, I. S.; Kopytin, I. V.; Beda, V. M. (Voronezh State Univ., USSR). Yadern. Fiz.; 22: No. 2, 276-288(Aug 1975). (In Russian)

The once-forbidden β transitions to the ground and first excited states of nuclei in the vicinity of ^{124}Sb are considered. The matrix elements are calculated in the framework of the theory of finite Fermi Systems. The Buring's approach is used to evaluate the following characteristics of β transitions: the shape of the spectrum, the reduced life-time, the $\beta\gamma$ angular correlation coefficients for polarized and nonpolarized γ quanta, the electron capture to β^+ decay probability ratio. The calculation results are compared with the available data. (3 tables, 4 figures) (auth)

4417 NEW MASS MEASUREMENTS OF SAMARIUM AND GADOLINIUM AND A MASS TABLE FOR THE LIGHT RARE EARTHS. Kayser, D.C.; Johnson, W.H. Jr. (School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455). Phys. Rev. C 12: No. 3, 1054-1063 (Sept 1975).

The 41-cm double-focusing mass spectrometer at the University of Minnesota has been used to measure the atomic masses of ^{152}Sm and ^{154}Sm and the isotopic mass differences of most Sm and Gd isotopes. Through the use of a new generalized error signal technique, measurements on the narrow doublets of Sm and Gd chlorides gave improved mass differences over previous work in this mass region. Where intense peaks were available, the results are consistent with errors of 0.4 to 1.0 μu. The conventional wide doublet technique was used to measure Sm-hydrocarbon doublets, yielding the masses of ^{152}Sm and ^{154}Sm with errors of less than 4 μu. These new mass data, when combined with other mass measurements and reaction data of comparable accuracy, are used in a least-squares mass adjustment in the range of 141 to 160 u. (auth)

4418 ^{13}C+^{144}Sm NEUTRON-TRANSFER REACTION. Thornton, S.T. (Max-Planck-Institut für Kernphysik, Heidelberg, Germany); Ford, J.L.C. Jr.; Friedland, E.; Wiedner, C.A.; Goldschmidt, M. Phys. Rev. C 12: No. 3, 877-886 (Sept 1975).

Angular distributions have been obtained for the ^{144}Sm(^{13}C,^{13}C)^{144}Sm$_{g.s.}$, ^{144}Sm(^{13}C, ^{14}C)^{143}Sm$_{0.75}$, and ^{144}Sm(^{13}C,^{14}C)^{143}Sm$_{1.10}$ reactions at 66 MeV. In addition, several states in ^{143}Sm and ^{145}Sm were identified by bombardment of ^{144}Sm in the reactions (^{13}C,^{14}C) and (^{13}C,^{12}C), respectively, at 72 MeV for $\theta_{lab}=30°$. Optical model parameters were deduced and a full finite-range recoil distorted-wave Born approximation analysis provided C^2S values and J^π assignments for levels in ^{143}Sm and ^{145}Sm. The use of heavy-ion reactions in conjunction with light ion results is shown to be a useful nuclear spectroscopic tool. (auth)

4419 DECAY OF 5.8-min ^{140}Pm^m AND 10-sec ^{140}Pm^g TO LEVELS OF ^{140}Nd. Zalutsky, M.R.; Macias, E.S. (Department of Chemistry, Washington University, St. Louis, Missouri 63130). Phys. Rev. C 12: No. 3, 997-1002 (Sept 1975).

The nuclear level structure of ^{140}Nd has been investigated by studying the decay of 5.8-min ^{140}Pm^m and 10-sec ^{140}Pm^g with Ge(Li) γ-ray detectors. Sources were produced via the ^{141}Pr(^{3}He,4n) reaction. The study of ^{140}Pm^g decay utilized a helium-jet recoil transport system. Fourteen γ rays were assigned ^{140}Pm^m decay and nine were attributed to ^{140}Pm^g decay. Decay schemes of ^{140}Pm^m and ^{140}Pm^g were constructed. Evidence for the low-spin members of the two-phonon triplet in ^{140}Nd is also presented. (auth)

4420 PARAMETER-DEPENDENT QUASISPIN GROUP. Lorazo, B. (Institut de Physique Nucléaire, Division de Physique Théorique, 91406 Orsay, France). Ann. Phys. (N.Y.) 92: No. 1, 95-141 (July 1975).

A nonconventional generalization of the quasispin formalism for N identical particles is presented. The generators $S_+ = \Sigma_i \rho_i S_+^i$, $S_- = \Sigma_i \rho_i^{-1} S_-^i$, and $S_z = \Sigma_i S_z^i$ of this quasispin group depend on the dynamical parameters ρ_i. This parameter-dependent quasispin group appears as a deformation of the conventional quasispin group ($\rho_i=1$). With such a definition of the quasispin group, the $2n$-projection $S_+^n|0>$ of the BCS state is seen to be an exact generalized seniority zero state. More precisely, this dynamical quasispin group provides the mathematical framework to discuss the earlier generalization of Talmi *et al.* Theoretical and numerical calculations of the generalized seniority zero multiplet have been carried out for the nickel and tin isotopes. (auth)

4421 STUDY OF ^{105}Ag AND ^{107}Ag WITH THE (p, t) REACTION. Del Vecchio, R.M.; Oelrich, I.C.; Naumann, R.A. (Joseph Henry Laboratories, Princeton University, Princeton, New Jersey 08540). Phys. Rev. C 12: No. 3, 845-855 (Sept 1975).

The ^{107,109}Ag(p, t)^{105,107}Ag reactions have been studied at 30 MeV bombarding energy. Tritons were detected with a 60 cm position-sensitive wire proportional counter backed by a plastic scintillator in the focal plane of a quadrupole-dipole-dipole-dipole (QDDD) spectrograph. Multiplet structure, interpretable as the coupling of a $2p_{1/2}$ proton to vibrational core states, was observed in both nuclei. In addition, some 50 levels in each nucleus were seen below about 3 MeV of excitation with a resolution of 10 keV. Distorted wave Born approximation calculations with simple two particle configurations worked rather well and permitted the determination of L transfers. A considerable amount of (p, t) strength in the region from 2-3 MeV of excitation in each nucleus was observed, not all of which could be associated with expected weak coupling to the 3$^-$ core state. (auth)

4422 INTERNAL CONVERSION STUDIES IN ^{144}Nd. Avignone, F.T. III (Department of Physics, University of South Carolina, Columbia, South Carolina 29208); Raman, S. Phys. Rev. C 12: No. 3, 963-966 (Sept 1975).

The relative electron intensities of eight transitions in ^{144}Nd were measured with a combination magnetic-Si(Li) spectrometer. The deduced internal conversion coefficients were compared with theoretical values in order to determine the multipolarity assignments for these transitions. With the assumption that the 618.0-keV transition is $E2$, the 476.8-, 582.4-, and 696.5-keV transitions were also found to be $E2$. The 301.7-, 778.6-, and 814.1-keV transitions were found to be predominantly $E1$. Our results are consistent with an $E0+M1+E2$ assignment for the 890.1-keV transition. The internal conversion studies confirm the spin and parity assignments for four excited states in ^{144}Nd which were previously proposed mainly on the basis of angular correlation measurements. (auth)

Nuclear Properties and Reactions, 150 ≤ A ≤ 189

Refer also to abstracts 4417, 4439, 4441, and 4442.

4423 (IKF-34, pp 19-21) DETERMINATION OF E2 AND E4 MATRIX ELEMENTS FOR SIX EVEN-EVEN NUCLEI IN THE LANTHANIDE REGION. Wollersheim, H. J.; Elze, T. W. (Univ., Frankfurt am Main). 1974. (In German).

In annual report, 1974. (Frankfurt Univ. (F. R. Germany). Inst. fuer Kernphysik).

4424 (LBL-4000, pp 16-17) LEVELS OF ^{156}Dy AND DECAY SCHEME OF ^{156}Ho ISOMERS. Iwata, S. (Kyoto Univ., Kumatori, JA); Tamura, T.; Rasmussen, J. O.; Needham, R. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4425 (LBL-4000, pp 47-49) EXCITATION FUNCTIONS OF COMPOUND NUCLEUS PRODUCTS FROM THE REACTION ^{40}Ar + ^{175}Lu. Alonso, J. R.; Alonso, C. T.; Ghiorso, A.; Nitschke, J. M.; Nurmia, M. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4426 (LBL-4000, pp 73-74) OPPOSITE INTERFERENCE EFFECTS OBSERVED IN THE ^{148}Sm(^{18}O,^{16}O)^{150}Sm AND THE ^{150}Sm(^{16}O,^{18}O)^{148}Sm REACTIONS. Maguire, C.; Harvey, B.; Hendrie, D.; Homeyer, H.; Jahnke, U.; Mahoney, J.; Scott, D.; Glendenning, N. K. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4427 (LBL-4000, pp 276-278) NUCLEAR ORIENTATION MEASUREMENT OF PARITY ADMIXTURE IN THE 501-keV GAMMA TRANSITION IN ^{180}Hf/sup m/. Chou, T. S.; Krane, K. S.; Shirley, D. A. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4428 (NP-20526, pp 50-51) IN-BEAM γ SPECTROSCOPIC STUDY OF ^{151}Eu. Taketani, H. (Tokyo Inst. of Tech.); Adachi, M.; Hattori, T.; Matsuzaki, T.; Yoshikawa, N.; Kawakami, H. 1974.

In Institute for Nuclear Study annual report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

4429 HALF-LIFE AND DECAY OF THE LONG-LIVED ISOMER OF ^{150}Eu. Nethaway, D.R.; Mendoza, B.; Newbury, R.S. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). Phys. Rev. C 12: No. 4, 1310-1313 (Oct 1975).

The half-life of the long-lived isomer of ^{150}Eu has been measured to be 35.8±1.0 yr. Two methods were used for the measurements. In the first, the ^{150}Eu half-life was measured relative to that of ^{147}Eu, ^{148}Eu, ^{149}Eu, and ^{152}Eu by measuring the atom ratios and disintegration-rate ratios in a mixed tracer solution using mass-spectrometric and Ge(Li) counting techniques. The second method involved studying the γ spectrum of three mass-separated ^{150}Eu sources over periods of up to 6.1 yr with several NaI(Tl) detectors. No evidence was found for the 6.2 yr half-life which has been previously reported for ^{150}Eu. (auth)

4430 NUCLEAR MAGNETIC DIPOLE MOMENT OF ^{181}Ta. Sugar, J.; Kaufman, V. (National Bureau of Standards, Washington, D.C. 20234). Phys. Rev. C 12: No. 4, 1336-1339 (Oct 1975).

The hyperfine structure of the $6s^2S_{1/2}$-$6p^2P_{1/2}$ line of Ta V at 1708 Å has been resolved using a 150 A sliding spark discharge. The $6p$-$8s$ multiplet was identified and the ionization energy was redetermined. With these new data a value for the nuclear dipole moment of ^{181}Ta of (2.36 ± 0.02) μ_N is derived. New wavelengths are given for all previously classified lines. (auth)

4431 PENETRATION EFFECTS FOR INTERNAL CONVERSIONS IN THE ODD-MASS ISOTOPES OF La AND Cs. Morinaga, A.; Hisatake, K. (Tokyo Inst. of Tech. (Japan)). J. Phys. Soc. Jpn.; 38: No. 2, 322-329(Feb 1975).

Penetration parameters λ are determined by using internal conversion intensities and coefficients for low energy hindered M1 transitions of ^{131}Cs, ^{135}La, ^{137}La and ^{139}La together with E2/M1 mixing ratios δ^2. The results are: λ(86.9, ^{135}La) = 14.5 ± 5.5, λ(10.5, ^{137}La) = 10 ± 5, λ(166, ^{139}La) = 3.6 ± 1.8 and λ(92.3, ^{131}Cs) = 4 ± 4, where numbers in parentheses are transition energies in keV. (auth)

4432 BETA TRANSITIONS OF THE ^{166}Ho NUCLEUS. Bogdan, D. (Inst. of Atomic Physics, Bucharest); Cretu, T.; Fuia, G.; Macarie, G. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 20: No. 2, 133-140(1975).

New calculations procedures are used for the theoretical beta decay observables for the $0^- \rightarrow 2^+$ and $0^- \rightarrow 0^+$ transitions. The Woods-Saxon and Nilsson wave functions are used. For the $0^- \rightarrow 0^+$ transition and energy dependent shape spectrum (in agreement with experiment) is obtained only in the framework of the Woods–Saxon model. (auth)

4433 NEW DATA ON THE DECAY ^{168}Tm → ^{168}Er. Abdurazakov, A. A.; Budzinski, M.; Ion-Mikhai, R.; Islamov, T. A.; Morozov, V. A.; Muminov, T. M.; Subotovich, M.; Fominykh, V. I.; Fuya, Kh.; Khalbaev, I. (Joint Inst. for Nuclear Research, Dubna, USSR). Rev. Roum. Phys.; 20: No. 3, 273-281(1975). (In Russian)

Research on the electron internal conversion spectrum of thulium-168 is carried out using the beta spectrograph and on the gamma–gamma coincidence spectra using Ge(Li) detectors. The gamma–gamma angular correlations are studied using the Ge(Li) and NaI(Tl) detectors. New transitions are discovered in the internal conversion electron spectra: 27.90, 73.89, 74.68, 75.55, 110.05, 138.15, 173.7, and 183.9 keV. The data on gamma–gamma angular correlations allow one to determine the multipolarities for gamma transitions: 198.2, 631.6, 915.9, and 829.9 keV. (tr-auth)

4434 GROUND STATES IN THE NEUTRON-DEFICIENT $165 \leq A \leq 185$ REGION. Harmatz, B.; Horen, D.J.; Ellis, Y.A. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). Phys. Rev. C 12: No. 3, 1083-1086 (Sept 1975).

In the rare-earth deformed region, shifts from systematic Nilsson ground-state assignments are suggested for ^{177}W, ^{181}Os, and for ^{171,173}Ta. Other proposed changes in the regular ordering of Nilsson ground states in the $71 \leq Z \leq 77$ region far from the β-stability line are discussed. (auth)

4435 CHARACTER OF THE 1775 keV STATE IN ^{184}W. Casten, R.F.; Macphail, M.R.; Kane, W.R. (Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. C 12: No. 3, 821-826 (Sept 1975).

The populations of levels in ^{184}W in the (n,γ) reaction are studied. On the basis of the technique of population systematics it is argued that the 1713 and 1775 keV levels are not the 1^+ and 2^+ members of a $K=1$ rotational band as recently proposed. Rather it is shown that the 1775 keV level is most likely a $K=2$ bandhead. Arguments from earlier charged particle reaction data support these conclusions whose implications are important in the study of the breakdown of the Nilsson model in this mass region. An assessment is made of current interpretations of the states between 1600 and 1900 keV in ^{184}W. (auth)

Nuclear Properties and Reactions, 190 ≤ A ≤ 219

Refer also to abstracts 4126, 4339, 4375, and 4452.

4436 (LBL-4000, pp 5-7) ALPHA DECAY STUDIES OF THE HIGH SPIN ISOMER OF BISMUTH-210. Tuggle, D.; Asaro, F.; Perlman, I. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4437 (LBL-4000, pp 7-9) K-SHELL ELECTRON SHAKE-OFF ACCOMPANYING ALPHA DECAY. Rapaport, M. S.; Asaro, F.; Perlman, I. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4438 (LBL-4000, pp 42-44) RECOIL RANGE STUDIES FROM REACTIONS OF ^{40}Ar WITH ^{209}Bi AND ^{232}Th. Otto, R. J.; Raunemaa, T.; Fowler, M. M.; Williams, K.; Seaborg, G. T. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4439 (LBL-4000, pp 97-99) ARGON-INDUCED TRANSFER REACTIONS AT COULOMB BARRIER ENERGIES. Eggers, R. C. (Texas A and M Univ., College Station, TX); Rasmussen, J. O.; Ribbe, W. S. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4440 (LBL-4000, pp 111-112) STUDY OF FRAGMENTS EMITTED IN THE INTERACTION BETWEEN ^{197}Au AND ^{40}Ar AT 288-MeV AND 340-MeV BOMBARDING ENERGY. Moretto, L. G.; Babinet, R.; Galin, J.; Schmitt, R.; Fraenkel, Z.; Jared, R.; Hunter, J.; Thompson, S. G. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4441 (LBL-4000, pp 114-115) FISSION EXCITATION FUNCTIONS IN MEDIUM-HEAVY NUCLEI. Moretto, L. G.; Gatti, R. C.; Schmitt, R. P.; Thompson, S. G. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4442 (NP-20526, pp 53) IN-BEAM γ-RAY STUDY OF ^{188,190}Pt. Numao, T. (Tokyo Inst. of Tech.); Yoshikawa, N.; Shida, Y.; Sakai, M. 1974.

In Institute for Nuclear Study annual report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

4443 (NP-20526, pp 54) CROSS SECTIONS OF (p,pxn) REACTIONS ON ^{208}Pb. Rasmussen, J. O.; Yoshikawa, N.; Kawakami, H.; Komura, K.; Koike, M.; Sakai, M. 1974.

In Institute for Nuclear Study annual report, January 1974-December 1974. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study).

4444 g FACTORS OF THE 9^- AND 12^+ ISOMERIC STATES IN ^{200}Pb. Young, L.E.; Bhattacherjee, S.K.; Brenn, R.; Brown, B.A.; Fossan, D.B.; Sprouse, G.D. (Department of Physics, State University of New York, Stony Brook, New York 11794). Phys. Rev. C 12: No. 4, 1242-1246 (Oct 1975).

The g factors of the 9^- state (2.236 MeV, $\tau = 694$ nsec) and the 12^+ state (~3.1 MeV, $\tau = 228$ nsec) in ^{200}Pb have been measured as $g\,(9^-) = -0.030(3)$ and $g\,(12^+) = -0.157(6)$ by a time-differential perturbed-angular-distribution technique. The states were populated by ^{197}Au(^{7}Li,4n)^{200}Pb(9^-) and ^{197}Au(^{6}Li,3n) ^{200}Pb(12^+) reactions with pulsed lithium beams. An in-beam superconducting magnet supplied a field of ~60 kG. The 9^- state g factor is in agreement with the additivity value obtained from empirical single-particle g factors for a $(i_{13/2}^{-1},\ f_{5/2}^{-1})9^-$ configuration and consistent with a small anomalous orbital contribution δg_l for the neutron. The g factor for the 12^+ state in ^{200}Pb is in surprisingly good agreement with those for the $(i_{13/2})^{-2}12^+$ state in ^{206}Pb and the $i_{13/2}^{-1}$ state in ^{205}Pb, in view of the possible existence of number-dependent effects. (auth)

4445 ISOMERISM IN ^{194}Au. Yates, S.W.; Lynch, F.J. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. C 12: No. 3, 1080-1082 (Sept 1975).

Isomeric states in ^{194}Au with half-lives of 600 ± 8 and 420 ± 10 ms have been studied by observing the delayed γ rays following the ^{194}Pt(p,n) and ^{194}Pt($d,2n$) reactions. γ-ray singles and γ-γ coincidence measurements were made and isomer cross section ratios were calculated. It is argued that the isomer at 80.5 keV has the shell model configuration $(\pi d_{3/2},\ \nu i_{13/2})5^+$, while the higher-lying isomer is believed to decay by an unobserved isomeric transition. (auth)

4446 ^{208}Pb(^{16}O,^{15}O)^{209}Pb REACTION. Becchetti, F.D. (Cyclotron Laboratory, Department of Physics, The University of Michigan, Ann Arbor, Michigan 48104); Harvey, B.G.; Kovar, D.; Mahoney, J.; Maguire, C.; Scott, D.K. Phys. Rev. C 12: No. 3, 894-900 (Sept 1975).

The neutron levels in ^{209}Pb have been studied with the ^{208}Pb(^{16}O,^{15}O) reaction at a bombarding energy of 139 MeV. Spectroscopic factors (S) have been deduced using a finite-range distorted-wave Born approximation (DWBA) with recoil. The $2g_{9/2}$, $1i_{11/2}$, $2g_{7/2}$, and $3d_{3/2}$ levels are found to have $S \lesssim 0.9$ while $S \simeq 0.7$ for the $1j_{15/2}$ level at 1.4 MeV excitation. Evidence is found for other $1j_{15/2}$ fragments being at 3.05 MeV and ~ 3.8 MeV with $S \simeq 0.08$ and 0.26, respectively, which would place the centroid of the $1j_{15/2}$ level at $E_x \simeq 2.2$ MeV. DWBA predicts a shift in the maxima of the angular distributions as a function of Q value which is not observed

experimentally. A comparison with the proton transfer reaction $^{208}Pb(^{16}O,^{15}N)^{209}Bi$ has been used to deduce the geometrical parameters of a neutron shell-model potential appropriate for nuclei with $A \gtrsim 200$. The parameters of this Woods-Saxon potential are: $V_R = -50.5$ MeV, $r_R = 1.19$ fm, $a_R = 0.75$ fm, $V_{so} = -5.5$ MeV, $r_{so} = 1.01$ fm, and $a_{so} = 0.75$ fm. (auth)

4447 DISCREPANCIES BETWEEN FORMATION AND DECAY OF ISOBARIC ANALOG STATES OF Pb AND Bi. Galonsky, A.; Crawley, G.M.; Miller, P.S.; Doering, R.R.; Patterson, D.M. (Cyclotron Laboratory and Department of Physics, Michigan State University, East Lansing, Michigan 48824). Phys. Rev. C 12: No. 3, 1072-1075 (Sept 1975).

For nuclei near $A = 208$, comparisons have been made between formation of isobaric analog states by the (p, n) reaction and their decay by proton emission. The discrepancy in cross sections is removed if the isobaric analog state formed in the (p,n) reaction is taken to have a Lorentzian rather than Gaussian line shape, and if the background of evaporation and preequilibrium protons is subtracted from the proton spectra. The latter procedure should also resolve the width anomaly. (auth)

4448 INVERSE α DECAY VIA THE REACTION $^{208}Pb(^{16}O, ^{12}C)^{212}Po$. DeVries, R.M.; Shapira, D. (Nuclear Structure Research Laboratory, University of Rochester, Rochester, New York 14627); Davies, W.G.; Ball, G.C.; Forster, J.S.; McLatchie, W. Phys. Rev. Lett. 35: No. 13, 835-838 (29 Sept 1975).

We have measured the reaction $^{208}Pb(^{16}O, ^{12}C)^{212}Po$ at $E_{16O} = 93$ MeV; the peak cross sections leading to the ground and first excited states of ^{212}Po are 750 and 1750 nb/sr, respectively. The reaction mechanism appears to be direct and excellent distorted-wave Born-approximation fits to the data yield a spectroscopic ratio of S (0.727 MeV, 2^+)/S (g.s.) $= 0.64 \pm 0.13$ in good agreement with the value 0.61 ± 0.24 derived from ^{212}Po α decay. Preliminary attempts at obtaining absolute α widths yield $\gamma_\alpha{}^2(^{212}Po(g.s.)) \sim 1.4$ keV from both α decay and the transfer reaction. (auth)

4449 HIGH-RESOLUTION STUDY OF ^{208}Pb WITH 35-MeV PROTONS. Wagner, W.T.; Crawley, G.M.; Hammerstein, G.R.; McManus, H. (Cyclotron Laboratory and Physics Department, Michigan State University, East Lansing, Michigan 48824). Phys. Rev. C 12: No. 3, 757-777 (Sept 1975).

The inelastic scattering of 35-MeV protons by ^{208}Pb was measured with a resolution of 5–8 keV. Angular distributions of states up to an excitation energy of about 8 MeV were obtained. Collective model calculations enabled the l transfers of many states to be identified. The possibility of excitation of 1^+ states is discussed. Microscopic model calculations were made with both phenomenological and theoretical information. The larger number of observed unnatural parity states permitted the role of noncentral forces in these transitions to be investigated. (auth)

Nuclear Properties and Reactions, A ≥ 220

Refer also to abstracts 3032, 4437, and 4438.

4450 (AEEW-R-1006) CURRENT UK POSITION ON URANIUM-238 RESONANCE CAPTURE IN THERMAL REACTORS. Askew, J. R. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Jun 1975. 29p. (CONF-750323-2). Dep. NTIS (US Sales Only) $4.50. UK HMSO £1.00.

From proceedings of 238U resonance capture; Upton, New York, USA (18 Mar 1975).

The large body of integral evidence of Uranium-238 resonance capture accumulated since 1966, when attention was first drawn to a discrepancy between integral evidence and calculated results based upon differential data, is reviewed. The experiments cover many reactor types, laboratories and measurement techniques, and include studies of isotopic composition of discharged fuel. It is shown that the discrepancy still exists, although changes in other data (particularly Uranium-235 resonance capture) have reduced the size of the deduced discrepancy to 4-8%. (Note added in proof: As the ENDF B IV data appears to give a higher resonance integral than the "basic" differential data chosen here, the correction required would be greater). It is argued that the differences are within the uncertainties of measurement of parameters for the low lying resonances which dominate thermal reactor calculations. These were originally believed to be more accurate because it was thought acceptable to assume capture widths invariant and to average them over many resonances. Once this is not permitted the differences become explicable. (auth)

4451 (LA-UR-75-1747) STATUS OF NEUTRON CROSS SECTIONS OF TRANSACTINIUM ISOTOPES IN THE RESONANCE AND FAST ENERGY REGIONS: UNDERGROUND NUCLEAR EXPLOSION MEASUREMENTS. Moore, M. S. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-eng-36. 28p. (CONF-751104-1). Dep. NTIS $4.50.

From IAEA advisory group meeting on transactinium isotope nuclear data; Karlsruhe, F. R. Germany (3 Nov 1975).

The nuclear explosion technique as a means of obtaining neutron cross-section data of actinide isotopes with half-lives of the order of days or longer is reviewed. The status of measurements previously made in this region (except for ^{232}Th, ^{233}U, ^{235}U, ^{238}U, and ^{239}Pu) is discussed. Some suggested corrections which may be in order for previously published data are described, and recommendations are made for possible future work by this technique. (6 figures, 4 tables, 45 references) (auth)

4452 (LBL-4000, pp 44-46) RADIOCHEMICAL MASS YIELD DISTRIBUTION STUDIES IN THE REACTION OF ^{40}Ar WITH ^{238}U AND ^{209}Bi AND 25.2 GeV ^{12}C WITH ^{238}U. Otto, R. J.; Fowler, M. M.; Lee, D.; Binder, L.; Seaborg, G. T. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4453 (LBL-4000, pp 50-53) ELEMENT 106. Ghiorso, A. (Univ. of California, Livermore); Hulet, E. K.; Nitschke, J. M.; Alonso, J. R.; Lougheed, R. W.; Alonso, C. T.; Nurmia, M.; Seaborg, G. T. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4454 (LBL-4000, pp 115-116) COMPLETE FUSION CROSS SECTIONS FOR THE $^{20}Ne + ^{235}U$ SYSTEM. Viola, V. E. Jr. (Univ. of Maryland, College Park); Zebelman, A. M.; Sextro, R. G.; Meyer, W. G.; Clark, R. G. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4455 (LBL-4000, pp 171-175) THEORETICAL ESTIMATES OF SPONTANEOUS-FISSION HALF-LIVES FOR SUPERHEAVY ELEMENTS. Randrup, J. (Lund Institute of Technology, Sweden); Larson, S. E.; Moeller, P.; Sobiczewski, A.; Tukasiak, A. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4456 (LBL-4000, pp 278-280) NUCLEAR ORIENTATION STUDIES OF ^{241}Am AND ^{255}Fm. Soinski, A. J.; Shirley, D. A. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4457 (ORNL-tr-4040) EXPERIMENTS ON CHEMICAL IDENTIFICATION OF SPONTANEOUSLY FISSIONABLE ISOTOPE OF ELEMENT 105. Zvara, I.; Belov, V. Z.; Korotkin, Yu. S.; Shalaevsky, M. R.; Shchegolev, V. A.; Hussonnois, M.; Zager, B. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1970. Translation by M. Gerrard of JINR-P12-5120. 16p. Dep. NTIS $4.50.

Experiments have been performed on the chemical separation of radioactive products obtained in the bombardment of americium-243 with accelerated neon-22 ions (compound nucleus-element 105) by adsorption of gaseous chlorides from flowing carrier gas on the surface of a glass tube, over which a temperature gradient was established. It was found that the chloride of the spontaneous fission activity present is less volatile than niobium chloride but not less volatile than hafnium chloride. Such volatility properties are predicted for element 105-ehatantalum. 18 decay events were detected. (2 tables, 1 figure) (auth)

4458 COLLECTIVE STATES IN ^{230}Th, ^{240}Pu, ^{244}Pu, AND ^{248}Cm EXCITED BY INELASTIC DEUTERON SCATTERING. Thompson, R.C.; Huizenga, J.R. (Nuclear Structure Research Laboratory, University of Rochester, Rochester, New York 14627); Elze, Th.W. Phys. Rev. C 12: No. 4, 1227-1235 (Oct 1975).

Energy spectra of inelastically scattered 16-meV deuterons were measured at angles of 90° and 125° using enriched targets of ^{230}Th, ^{240}Pu, ^{244}Pu, and ^{248}Cm. In each nucleus the ground state band is observed up to and including the $J^\pi = 8^+$ level. The β vibration $J^\pi = 0^+$ level is identified in ^{230}Th, and this and the remaining three nuclei evidence for the γ vibration is discussed. At least octupole bands are observed in each nucleus and K, J^π assignments are made in a number of cases. B ($E2$) and B ($E3$) values are extracted for selected levels. (auth)

4459 RECURSION RELATION AMONG 9-j SYMBOLS AND THE RATIOS U_L FOR NONUNIQUE L-th FORBIDDEN β-TRANSITIONS. Szybisz, L.; Seshagiri, Rao, V. (Kernforschungszentrum, Karlsruhe, Ger.). Lett. Nuovo Cim.; 14: No. 7, 237-240 (18 Oct 1975).

As an example of the recursion relation found among the 9-j symbols and the μ_L ratios for nonunique L-th forbidden β transi-

tions, previous results are presented for transitions where the single-particle wave functions describe the beta process satisfactorily. It is hoped that this study will completely clarify the troubles that arise when one compares the results one obtains for a given form factor coefficient using a previous work and a general computational program for the 9-j symbols. (JFP)

4460 HEAVY NUCLEI, SUPERHEAVY NUCLEI, AND NEUTRON STARS. Irvine, J. M. Oxford Studies in Nuclear Physics. New York: Oxford University Press (1975). 168p. $22.50.

The topics discussed include the observed systematics of heavy nuclei, nuclear models, nuclear correlations, collective rotations, nuclear stability and shell effects, fission and alpha decay, superheavy nuclei, and neutron stars. (JFP)

4461 MECHANISM OF (n,nf) REACTIONS AND DELAYED NEUTRONS. Maksyutenko, B. P.; Balakshev, Yu. F.; Volkova, G. I. (Pysical-Power Engineering Inst., Obninsk, USSR). Yadern. Fiz.; 22: No. 2, 251-256(Aug 1975). (In Russian)

It is shown that a fast variation of relative and total yields of delayed neutrons in the (n,nf) reaction energy region is due to the variation of the width of the distribution of cumulative yields of the isotope fragments caused by superposition of two Gaussian distributions from two fissionable nuclei. The relative yields of delayed neutrons from ^{238}U fission are used to calculate the energy behavior of the total absolute yield. The result is in a good agreement with direct measurements. (2 tables, 5 figures) (auth)

4462 SEARCH FOR AN ANISOTROPY BETWEEN *Ll* X RAYS AND γ RAYS IN THE DECAY OF ^{243}Cm. Zalutsky, M.R.; Macias, E.S. (Department of Chemistry, Washington University, St. Louis, Missouri 63130). Phys. Rev. C 12: No. 3, 1076-1079 (Sept 1975).

The anisotropy of *Ll* x rays and γ rays of ^{239}Pu following the decay of ^{243}Cm has been investigated. A Ge(Li) crystal with 250 eV resolution at 5.9 keV was used to detect *Ll* x rays. A NaI(Tl) crystal was used to detect six γ rays between 210 and 285 keV. The measured anisotropy is $A = (3 \pm 6) \times 10^{-3}$. This is less than 2% of the maximum predicted anisotropy assuming that the magnetic substate alignment has been completely retained in the coupling of cascade γ rays and x rays. (auth)

4463 OCTUPOLE STATES IN ^{246}Cm AND ^{248}Cm POPULATED BY INELASTIC DEUTERON SCATTERING. Yates, S.W.; Friedman, A.M.; Ahmad, I. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. C 12: No. 3, 795-800 (Sept 1975).

Vibrational states in ^{246}Cm and ^{248}Cm have been investigated by inelastic deuteron scattering. The $K^\pi = 0^-$, 1^-, and 2^- octupole states are identified in ^{246}Cm at 1251, 1080, and 842 keV, respectively. In ^{248}Cm several excited states above 1 MeV have been identified; however, definite assignments for these states, except a $J^\pi = 3^-$ state at 1095 keV and a $J^\pi = 2^+$ state at 1050 keV, could not be made. Differences between the ^{246}Cm and ^{248}Cm level spectra are interpreted in terms of their microscopic components. Reduced transition probabilities $B(E3)$ are extracted for the observed $J^\pi = 3^-$ levels and are compared with theoretical values available in the literature. (auth)

4464 VERY LOW ENERGY PHOTOFISSION OF ^{238}U. Bowman, C.D.; Schröder, I.G.; Dick, C.E. (National Bureau of Standards, Washington, D.C. 20234); Jackson, H.E. Phys. Rev. C 12: No. 3, 863-870 (Sept 1975).

The photofission cross section of ^{238}U was measured in the 2.75- to 5.75-MeV range. Cross sections as small as 2×10^{-11} b were detected. A shelf was observed which had been predicted to occur in the cross section owing to the dominance of radiative decay of levels in the second well. Barrier penetrabilities for both inner and outer barriers were determined from these measurements and together with penetrabilities from other measurements were used to infer a potential shape for ^{238}U. The total γ-ray strength function in the second well at 4.25 MeV was found to be 1.3×10^{-5}. From comparison of expected and measured cross sections at the lowest energies, the density of levels effective in photofission at 3 MeV was found to be greater than 4 per MeV. (auth)

4465 WESCOTT g_f-FACTOR FOR ^{239}Pu AND ITS TEMPERATURE DEPENDENCE. Wagemans, C.; Deruytter, A. J. (SCK/CEM, Mol, Belgium). Ann. Nucl. Energy; 2: No. 1, 25-28 (Jan 1975).

The Westcott g_f-factor, which is important for the interpretation of measurements with Maxwellian neutron spectra and reactor spectra, was calculated using recent accurate neutron induced fission cross section measurements. The value obtained was $g_f = 1.053 \pm 0.003$. The temperature dependence of g_f from 0°C to 1000°C was also calculated. (auth)

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Refer also to abstracts 3977, 4145, and 4245.

4466 (CONF-720133-4) IV BRAZILIAN SYMPOSIUM ON THEORETICAL PHYSICS. Volume XI. da Providencia, J.; Jacob, G.; de Toledo Piza, A. F. R.; Ripper Filho, J. E.; Brown, H.; Mendes, R. V.; Saavedra, I. (Coimbra Univ. (Portugal); Rio Grande do Sul Univ., Porto Alegre (Brazil). Instituto de Fisica; Sao Paulo Univ. (Brazil). Instituto de Fisica; Universidade Estadual de Campinas (Brazil); Sao Paulo Univ., Sao Carlos (Brazil). Instituto de Fisica e Quimica; Junta de Energia Nuclear, Sacavem (Portugal). Lab. de Fisica e Engenharia Nucleares; Chile Univ., Santiago. Departamento de Fisica). 1972. 107p. (In Portuguese and English). Dep. NTIS (US Sales Only) $8.50.

From 4th symposium on theoretical physics; Rio de Janeiro, Brazil (4 Jan 1972).

Separate abstracts were prepared for the six papers presented. (JFP)

For abstracts of individual papers see: 2852, 4175, 4467–4469, and 4594.

4467 (CONF-720133-4, pp 1-14) ANHARMONIC VIBRATIONS IN NUCLEI AND BOSON EXPANSIONS. da Providencia, J. (Univ., Coimbra). 1972.

From 4th symposium on theoretical physics; Rio de Janeiro, Brazil (4 Jan 1972).

In IV Brazilian symposium on theoretical physics. Volume XI.

The treatment of anharmonic vibrations in nuclei and boson expansions covers the semiclassical description of a collective vibration, a quantal description of a collective vibration–generator coordinate method, the anharmonic situation. (JFP)

4468 (CONF-720133-4, pp 15-27) RECENT RESULTS AND OPEN PROBLEMS IN QUASI-FREE SCATTERING. Jacob, G. (Rio Grande do Sul Univ., Porto Alegre, Brazil). 1972.

From 4th symposium on theoretical physics; Rio de Janeiro, Brazil (4 Jan 1972).

In IV Brazilian symposium on theoretical physics. Volume XI.

The review of recent results and open problems in quasi-free scattering includes previous as well as recent results and a description of some open problems including hole states, structure in inner shell peaks, short range correlations, structure in background, form factors of bound protons, and the variation of distortion, with energy. (JFP)

4469 (CONF-720133-4, pp 37-50) ANALYSIS OF UNSTABLE RESIDUAL STATES IN DIRECT NUCLEAR REACTIONS. de Toledo Piza, A. F. R. (Univ., Sao Paulo, Brazil). 1972.

From 4th symposium on theoretical physics; Rio de Janeiro, Brazil (4 Jan 1972).

In IV Brazilian symposium on theoretical physics. Volume XI.

The ideas of intermediate structure resonances and the underlying fine structure fluctuations in nuclear reaction cross sections as a function of energy are brought to bear on reactions in which intermediate structures are produced in the residual fragments rather than formed in the compound nuclear system. A prototype for the discussion is the (e,e'p) process. (JFP)

4470 (ITP-75-37P) RIEMANN SPACE AND THE GENERALIZED COLLECTIVE NUCLEAR MODEL. Tereshin, Yu. V. (AN Ukrainskoj SSR, Kiev, Inst. Teoreticheskoj Fiziki). 1975. 11p. (In Russian). Dep NTIS (US Sales Only) $4.00.

Starting from the symmetry properties the most generalized form of the Hamiltonian operator is obtained in the Riemann space of irreducible tensor operators. The formalism developed is illustrated by special examples. (auth)

4471 (LBL-4000, pp 154-157) NUCLEAR SEYLER–BLANCHARD MODEL IN THE HARTREE APPROXIMATION. Randrup, J. (Univ. of Aarhus, Denmark). Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4472 (LBL-4000, pp 179-183) THERMODYNAMICAL PROPERTIES OF A PAIRED NUCLEUS WITH A FIXED NUMBER OF QUASI-PARTICLES. Moretto, L. G. Jul 1975.

In nuclear chemistry. Annual report, 1974. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

4473 (LBL-4212) NEUTRON PRODUCTION FROM HEAVY ION INTERACTION: SOME VERY EMPIRICAL CONSIDERATIONS. Rindi, A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 11 Jul 1975. Contract W-7405-eng-48. 24p. (CONF-751025-1). Dep. NTIS $4.25.

From course on high energy radiation dosimetry and protection; Erice, Italy (1 Oct 1975).

In the last few years there has been increasing interest in the use of heavy ion accelerators for research in nuclear physics, radiobiology, medicine and space science. Neutrons of energy up to that of the primary accelerated heavy ion may be produced by interaction with matter. The knowledge of the yield and energy

spectrum of these neutrons is of fundamental importance in all the fields of application of heavy ions. Very little is known from the theoretical as well as experimental point of view about the production of these neutrons. The theory associated with neutron production is summarized and the scarce experimental results accumulated up to now are reported. (7 figures, 5 tables) (auth)

4474 CHIRAL SYMMETRY AND PION CONDENSATION. I. MODEL-DEPENDENT RESULTS. Campbell, D.K. (Theoretical Division, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544); Dashen, R.F.; Manassah, J.T. Phys. Rev. D 12: No. 4, 979-1009 (15 Aug 1975).

The successes of current algebra and partial conservation of axial-vector current can be interpreted as indications that the strong interactions are approximately symmetric under chiral SU(2) $\times$ SU(2) transformations. In the absence of matter, the explicit chiral-symmetry breaking, which conserves isospin and gives the pion a small mass, defines a unique vacuum state for the theory. The smallness of the chiral-symmetry breaking, however, implies the existence of many other states, approximately degenerate in energy with, but orthogonal to, the true vacuum. In these states, which can be obtained formally from the vacuum by a chiral rotation, in general the expectation value of the π field in the ground state, $\langle\pi\rangle \neq 0$; thus they contain a "pion condensate." At zero baryon density these states are unphysical, but in a macroscopic system—such as a neutron star—at very high baryon density one of these pion-condensed states might become the true ground state. In this first of a series of papers on the implications of chiral symmetry for pion condensation, we study this phenomenon in the linear σ model. As a consequence of the simplicity of this model (and of a series of justifiable approximations) we are able to calculate analytically the "phase diagram" describing the ground state of infinite nuclear matter as a function of baryon density. We find that above a critical baryon density $\rho_c \simeq O(\rho_{\text{nucl}})$ a phase transition to a pion-condensed ground state occurs. To correct the most obvious phenomenological deficiencies of this simple model we extend the chiral-symmetry approach to include the effects of the N^* (1236) and the ill-understood πN s waves. Further, we indicate briefly additional effects which must be included in any serious quantitative description of real pion condensation. In addition to analyzing the ground state, we examine briefly the spectrum of excited states, an understanding of which is vital to the explanation of the cooling mechanism of neutron stars. In the condensed phase, the meson excitation spectrum contains a "Goldstone boson" associated with the ground state's not being an eigenstate of the conserved operator I_3. However, when electromagnetic interactions are included, this mode disappears via the Higgs phenomenon indicating that the ground state is a superconductor; thus only plasma excitations remain in the meson spectrum. The presence of the pion condensate fosters the β decay of the fermion excitations, and the emitted neutrinos provide the cooling mechanism for neutron stars. (auth)

4475 CHIRAL SYMMETRY AND PION CONDENSATION. II. GENERAL FORMALISM. Campbell, D.K. (Theoretical Division, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544); Dashen, R.F.; Manassah, J.T. Phys. Rev. D 12: No. 4, 1010-1025 (15 Aug 1975).

The role of chiral symmetry in pion condensation was explored through model calculations in the preceding paper. Here we present model-independent results which justify and sometimes go beyond the previous work. Our methods are based on functional techniques used in field theory. The paper is not self-contained and is meant to be read in conjunction with the preceding one. In the course of this work we were led to look at low-energy π-N interactions. In a brief survey, it is pointed out that they are more complicated than is commonly assumed. (auth)

4476 ISOBAR-DOORWAY MODEL AND MULTIPLE SCATTERING TECHNIQUES IN PION-NUCLEUS SCATTERING. Friedman, W.A. (University of Wisconsin, Physics Department, Madison, Wisconsin 53706). Phys. Rev. C 12: No. 4, 1294-1300 (Oct 1975).

An isobar-doorway model is presented for π-nucleus scattering in the (3,3) energy region. The connection between this model and multiple-scattering and optical-model approaches is demonstrated through various approximations used in evaluating the doorway amplitude. Effective scattering amplitudes, differing from the free π-N amplitudes as the result of nuclear effects, are suggested for use in multiple-scattering expansions. The importance of a factor $\Gamma^{\downarrow}$ in these amplitudes is marked. (This factor seems associated with a phenomenon analogous to collision broadening for atomic collisions.) An extension of the formalism to (π^+,π^0) charge exchange between analog states is given. (auth)

4477 MULTIPLE-DIFFRACTION EXPANSION FOR INTERMEDIATE-ENERGY REACTIONS. Wong, C.W.; Young, S.K. (Department of Physics, University of California, Los Angeles, California 90024). Phys. Rev. C 12: No. 4, 1301-1309 (Oct 1975).

A multiple-diffraction expansion for heavy-ion reactions is constructed in which the leading term is Glauber's phenomenological multiple-diffraction amplitude. This is achieved with the help of a pseudopotential between elementary particles in ions which in the Glauber approximation gives the empirical elementary scattering amplitude. The leading corrections to Glauber's phenomenological amplitude include (i) a wave-spreading term of Wallace, (ii) an internal-excitation term of Hahn, (iii) a pseudopotential term which contains effects of wave spreading and zero-point motion of bound particles in ions, and (iv) a Pauli term for antisymmetrizing two clusters of identical fermions. Explicit expressions for these corrections are given in the impact-parameter representation. The nature of these corrections is briefly discussed. (auth)

4478 SHELL MODEL THEORY OF RADIATIVE PION CAPTURE. Vergados, J.D. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19174). Phys. Rev. C 12: No. 4, 1278-1293 (Oct 1975).

The formalism for calculating the radiative pion capture cross section has been developed for shell model calculations in the impulse approximation. It includes the momentum dependent terms of the effective transition operator for any angular momentum of the pion. The giant dipole and giant quadrupole resonances are discussed. The quasifree background is calculated within the framework of the distorted wave impulse approximation. Realistic shell model calculations for ^{16}O yield good agreement with experiment. (auth)

4479 GAUSSIAN EXPANSIONS IN DISTORTED-WAVE-BORN-APPROXIMATION CALCULATIONS. Payne, G.L.; Carlson, R.R. (Department of Physics and Astronomy, The University of Iowa, Iowa City, Iowa 52242). Phys. Rev. C 12: No. 4, 1260-1270 (Oct 1975).

The use of Gaussian expansions for the bound-state functions in distorted-wave–Born-approximation calculations is discussed. The use of these expansions leads to an analytic expression for the form factor which can be used to simplify the numerical evaluation of the matrix element. In addition, the Gaussian functions are useful when studying the structure of the form factor. In particular, the validity of the "no-recoil" approximation is discussed and a semiclassical interpretation is presented. A computer program (GAUSS) using the Gaussian expansions has been developed and used to evaluate the cross sections of some previously studied reactions. Comparisons of the results with those of other programs are given. (auth)

4480 ENERGY AND ANGULAR MOMENTUM DEPENDENCE OF COMPLETE FUSION CROSS SECTIONS. Seglie, E.; Sperber, D. (Rensselaer Polytechnic Institute, Troy, New York 12181). Phys. Rev. C 12: No. 4, 1236-1241 (Oct 1975).

A model for the calculation of the cross section for complete fusion in heavy ion reactions is suggested. The model does not explicitly depend on the sharp cutoff approximation. On the contrary, it allows for a gradual transition between compound and direct process when the bombarding energy is sufficiently high above the Coulomb barrier. The energy below which the reaction cross section is exhausted by compound processes is also estimated. Comparison with experimental results supports the validity of the model. (auth)

4481 EXCHANGE EFFECTS IN THE COUPLED-EQUATIONS NUCLEAR-REACTION FORMALISM. Tobocman, W. (Physics Department, Case Western Reserve University, Cleveland, Ohio 44106). Phys. Rev. C 12: No. 4, 1146-1151 (Oct 1975).

Exchange symmetry is used to eliminate reference to physically indistinguishable channels in the coupled-equations nuclear-reaction formalism. The resulting equations are similar in structure to the original ones except that they are far fewer in number and the interactions contain exchange operators. (auth)

4482 DIFFERENCES OF DEFORMATION PARAMETER β FOR DIFFERENT TRANSITION MECHANISMS; COMPARISON WITH DATA. Madsen, V.A.; Brown, V.R.; Anderson, J.D. (Lawrence Livermore Laboratory, Livermore, California 94550). Phys. Rev. C 12: No. 4, 1205-1211 (Oct 1975).

The differences between the isovector and isoscalar parts of the collective deformation parameter β are obtained from the results of microscopic effective-charge theory. For single-closed-shell nuclei, differences, due to the isovector parts, of up to about 20% between $\beta_{nn'}$ and $\beta_{pp'}$ are predicted, $\beta_{nn'}$ being much closer to β_{np} than to $\beta_{pp'}$. Data on single-closed-shell nuclei are tabulated and their general trend supports our predictions. (auth)

4483 TWO MODES OF COLLECTIVE EXCITATIONS OF A FERMI-LIQUID DROP AND SUM RULES FOR ELECTROMAGNETIC TRANSITIONS IN ATOMIC NUCLEI. Khodel', V.A. (I. V. Kurchatov Institute of Atomic Energy). JETP Lett. 21: No. 11, 317-318 (5 June 1975).

The problem of the appearance of low-lying collective excitations in a drop of normal Fermi liquid is considered. In a quantum drop there are two collective-excitations modes, rather than one, the lower being the analog of ordinary capillary waves and the other the analog of zero sound. It is shown that both modes make comparable contributions to the sum rule. (auth)

4484 PION EXCHANGE MECHANISM FOR (π^+, 2p) REACTIONS. Wienke, B. R. (California Univ., Los Alamos, N. Mex. (USA). Los Alamos Scientific Lab.). Prog. Theor. Phys. (Kyoto); 52: No. 2, 567-577(Aug 1974).

Motivated by static s- and p-wave pion-nucleon interactions, general expressions for the amplitudes and cross sections for the processes A(π^+, 2p) A-2 are obtained for arbitrary states with correlated and uncorrelated nucleons. The treatment is based on field theory and presented to order g^2 in the usual pion-nucleon coupling constant. As such, the analysis prescribes an off-mass-shell behavior of the pion in lowest order. Distortion of the protons is also considered. (auth)

4485 SYSTEMATICS OF FISSION FRAGMENT MASS-YIELD CURVES. Moriyama, H.; Ohnishi, T. (Kyoto Univ., Uji (Japan). Inst. of Atomic Energy). Tech. Rep. Inst. At. Energy, Kyoto Univ.; No. 166, 1-22(Sep 1974).

77 refs.

It becomes clear that fission fragment mass-yield curves obey a systematics. Empirical equations for the curves are proposed; the post-neutron-emission yield of the fragment with the mass A originating from the fissioning nuclide (Z_f, A_f) is expressed only in terms of A, Z_f, A_f, and E, E being the excitation energy of the fissioning nuclide from its ground state. These empirical equations can explain the experimental fragment yield of the nuclide with $Z_f^2/A_f \lesssim 40.2$ and $0 \leq E \lesssim 60$ MeV within an accuracy of 20%. The formulas for the mass distribution curve after the delayed-neutron emission are also proposed. The fragment mass-yield curves for the nuclides not yet investigated experimentally are predicted. (auth)

4486 HARD (SOFT) CORE NUCLEON–NUCLEON POTENTIALS INVOLVED IN THE TWO-NUCLEON STRIPPING REACTION MATRIX. Carstoiu, F.; Dumitrescu, O.; Popescu, D. G. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 20: No. 2, 117-131(1975).

Finite range nucleon–nucleon interaction of the hard (soft) core types is involved in the two nucleon stripping reaction matrix element obtained in the framework of the "adiabatic" coupled-channels Born approximation (ACCBA). (auth)

4487 COMMENTS ON THE RECENT THEORY OF K-ELECTRON SHAKE-OFF IN BETA-DECAY. Isozumi, Y.; Shimizu, S. (Kyoto Univ.). Lett. Nuovo Cim.; 14: No. 6, 193-196(11 Oct 1975).

In order to resolve an argument concerning K-electron shake-off in beta decay, an elementary mistake in a previous formulation with the second-quantization description is directly revealed. (JFP)

4488 RECOVERY OF THE ROTATIONAL SYMMETRY IN CALCULATIONS OF NUCLEAR DEFORMATION ENERGY. Kolomiets, V. M. (Inst. for Nuclear Research, Kiev). Yadern. Fiz.; 22: No. 2, 269-275(Aug 1975). (In Russian)

Correction to the deformation energy due to an account of the rotational symmetry of the nuclear wave function is renormalized according to the shell-correction method. It is shown that one may neglect the violation of the rotational symmetry in calculations of stationary characteristics of the deformation energy (positions of the extrema for the deformation energy, heights of the fission barriers). (auth)

4489 SPIN DEPENDENCE OF THE LEVEL SPECTRUM OF THREE RESONANTLY INTERACTING PARTICLES. Bulgak, A.; Efimov, V. (Leningrad Inst. of Nuclear Physics). Yadern. Fiz.; 22: No. 2, 296-307(Aug 1975). (In Russian)

Recently, it was found that resonances in the two-body forces lead to a series of three-particle spectra. The levels have some peculiar features, their number may be very large. The spin (isospin) effect on the spectrum is studied. A general method to describe the effect for any spins is proposed. The calculation results for some specific spin values are given. For nuclei with spins the effect is not so strong as for spin zero nuclei, although sometimes an opposite situation is possible. (5 figures) (auth)

4490 ONE-PION INTERACTION OF NUCLEONS IN NUCLEI. Sapershtein, E. E.; Troitskii, M. A. (Physical-Chemistry Inst., Moscow). Yadern. Fiz.; 22: No. 2, 257-268(Aug 1975). (In Russian)

The effect of the one-pion interaction on the properties of nuclear matter and atomic nuclei is analyzed. The one-pion-exchange terms are extracted in the equations of the theory of finite Fermi systems. The effective field equation is formulated in the region of stability of the homogeneous nuclear matter, as well as for the case when the stability is violated and a π-meson condensate is produced in a nucleus. It is shown that a correct consideration of the one-pion interaction allows to explain the enhancement of l-forbidden M1 transitions in a number of nuclei. (4 tables, 3 figures) (auth)

4491 INVERSE PROBLEM FOR PROCESSES WITH EXCITATION OF COLLECTIVE NUCLEAR STATES AND FOR VELOCITY-DEPENDENT POTENTIALS. Zakhar'ev, B. N.; Suz'ko, A. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 22: No. 2, 289-295(Aug 1975). (In Russian)

It is shown that from the scattering data one is able to reconstruct the nuclear optical potential V(r), its radial and angular dependence, despite rotations and vibrations of the target that make the picture of interaction between the incident particle and the nucleus more complicated. The inverse problem is formulated also for potentials depending on $\hat{p}^2_{(op)}$ ($\hat{p}_{(op)}$ is the momentum operator). (auth)

4492 ALIGNING OF COMPOUND NUCLEI BY THE ORBITAL MOMENTUM OF THE INCIDENT PARTICLE. Kozlovskii, L. K.; Rabotnov, N. S. (Physical-Power Engineering Inst., Obninsk, USSR). Yadern. Fiz.; 22: No. 2, 308-311(Aug 1975). (In Russian)

It is shown that the widely used statement on the aligning of compound nuclei in the plane orthogonal to the beam is not always valid. In some cases (depending on the relation of the target spin to the orbital momentum of the incident particles) there may appear a strong inverse effect i.e. a dominant aligning along the beam direction. The alignment of compound nuclei is calculated as a function of the nuclear target spin and of the neutron momentum. The obtained results are discussed in connection with the angular distributions of fragments of nuclear fission induced by neutrons. (1 table) (auth)

4493 SPACE AVERAGING TECHNIQUES OF DETERMINANTAL MEASURES. Kelson, I.; Shadmon, G. (Tel-Aviv Univ., Israel). J. Math. Phys. (N. Y.); 16: No. 11, 2224-2232 (Nov 1975).

Techniques for evaluating approximate space-averages of determinantal measures are discussed. The concept of combinatorial structure diagrams is introduced and investigated. (auth)

4494 ELECTROMAGNETIC CORRECTIONS TO THE INDUCED PSEUDOSCALAR TERM IN NUCLEAR MUON CAPTURE. Fulcher, L. P. (Univ. of Maryland, College Park); Mukhopadhyay, N. C. Nuovo Cim.; 28A: No. 4, 487-509(21 Aug 1975).

The electromagnetic corrections to the induced pseudoscalar term in nuclear muon capture are studied. The effects of the static nuclear magnetic field are shown to be very small. The effects of the nuclear Coulomb field are calculated by constructing the Green's function appropriate for pions moving in the Coulomb field of an extended nucleus and using realistic muon wave functions. Consideration of finite nuclear size is shown to be imperative in order to obtain accurate results. The Coulomb corrections are not large enough to play any significant role in understanding the discrepancy of the theory with the recent measurement of the photon spectrum following radiative muon capture in ^{40}Ca of the rate of the reaction ^{16}O(mu$^-$, nu/sub mu/)^{16}N(0$^-$). Two approximate methods of obtaining the results are also presented. (auth)

4495 TEST OF MANY-BODY METHODS ON AN EXACTLY SOLUBLE MODEL WITH BACKBENDING AND GAPLESS SUPERCONDUCTIVITY. Chu, S.Y.; Marshalek, E.R.; Ring, P.; Krumlinde, J.; Rasmussen, J.O. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. C 12: No. 3, 1017-1034 (Sept 1975).

The exactly soluble R(8) model of Krumlinde and Szymański is used as a testing ground for three many-body methods applied to the yrast band: (i) the self-consistent cranking model, (ii) self-consistent cranking plus random-phase approximation, and (iii) variation after projection of particle number. All three methods agree very well with exact results outside of the critical region. The behavior in the critical region is examined in detail. (auth)

4496 COMPARISON OF THE ANGULAR VELOCITY AND THE ANGULAR MOMENTUM EXPANSIONS FOR YRAST BAND LEVEL ENERGIES IN EVEN-EVEN NUCLEI. Sood, P.C.; Jain, A.K. (Nuclear Physics Section, Department of Physics, Banaras Hindu University, Varanasi 221005, India). Phys. Rev. C 12: No. 3, 1064-1068 (Sept 1975).

The results from the three- and the four-parameter expessions of the angular velocity expansion (AVE) and the angular momentum expansion (AME) are compared with the available experimental information on transition energies for yrast band levels in even-even nuclei. It is found that from the point of view of range of applicability, degree of fit to experimental transition energies, and high spin behavior, AME gives distinctly better results than AVE. The critical spin for backbending calculated from three-parameter AME is found to be in a fair agreement with the experimental data. (auth)

4497 ALTERNATIVE LONGITUDINAL COORDINATIONS OF THE EXCITED STATES IN EVEN-EVEN NUCLEI. Piepenbring, R. (Institut des Sciences Nucléaires, 38044 Grenoble Cédex, France). Phys. Rev. C 12: No. 3, 1087-1088 (Sept 1975).

The aim of the present letter is to show that there exist two different longitudinal *coordinations* of the collective vibrational levels built on several quadrupole phonons (d bosons). The first one reproduces that given earlier by Sakai. The second one explains and generalizes the X, Y, Z, X', Z', β, and Δ bands recently introduced by Iachello and Arima. (auth)

4498 GENERALIZATION OF THE FESHBACH UNIFIED NUCLEAR REACTION THEORY TO REARRANGEMENT COLLISIONS. Tobocman, W. (Physics Department, Case Western Reserve University, Cleveland, Ohio 44106). Phys. Rev. C 12: No. 3, 741-743 (Sept 1975).

A multipartition version of the Feshbach unified nuclear reaction theory is formulated. The new theory can deal with rearrangement processes as well as with elastic and inelastic processes. The generalization results from replacing the Lippmann-Schwinger equation for the transition operator by the Baer-Kouri or Kouri-Levin coupled integral equations. (auth)

4499 RELATIVISTIC HYDRODYNAMIC THEORY OF HEAVY-ION COLLISIONS. Amsden, A.A.; Bertsch, G.F.; Harlow, F.H.; Nix, J.R. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). Phys. Rev. Lett. 35: No. 14, 905-908 (6 Oct 1975).

By use of finite-difference methods we solve the classical relativistic equations of motion for the head-on collision of two heavy nuclei. For ^{16}O projectiles incident onto various targets at laboratory bombarding energies per nucleon $\leq$ 2.1 GeV, curved shock waves develop. The target and projectile are deformed and compressed into crescents of revolution. This is followed by rarefaction waves and an overall expansion of the matter into a moderately wide distribution of angles. (auth)

4500 REACTIVE CONTENT OF THE SINGLE-SCATTERING OPTICAL POTENTIAL. Tandy, P.C.; Redish, E.F.; Bollé, D. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). Phys. Rev. Lett. 35: No. 14, 921-924 (6 Oct 1975).

A unitarity relation is derived for the nucleon-nucleus scattering amplitude which displays the reaction mechanisms associated with the absorptive part of the single-scattering optical potential. The reactions implicit in the absorption are nucleon pickup and knockout. The transition amplitudes for these processes are extracted from the unitarity relation and their accuracy is discussed. (auth)

4501 DIRECT REACTION EFFECTS ON COMPOUND CROSS SECTIONS. Moldauer, P.A. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. C 12: No. 3, 744-756 (Sept 1975).

Two effects of a direct reaction on compound processes are discussed: the enhancement of the average compound cross section that competes with the direct process and the cross correlations in the fluctuations of cross sections involving the directly coupled channels. For the case of two directly coupled channels it is shown that both effects are maximized at the causality limit of the average S matrix where the penetration matrix P is singular. Computer experiments demonstrate that both effects fall off sharply when $\bar{S}$ is not near this causality limit and similar reductions in the effects are expected when more than two channels are strongly coupled to one another. A formula based upon the Engelbrecht-Weidenmüller transformation and the M-cancellation principle gives an excellent account of the enhancements obtained from the computer experiments. It also gives a qualitative account of the magnitudes of the cross section cross correlation coefficients. A somewhat more complicated formula due to Hofmann *et al.* also gives a good account of the enhancements. Both of these formulas agree with that of Kawai *et al.* in the limit of large width-to-spacing ratios. (auth)

4502 RELATIVISTIC ANGULAR MOMENTUM RELATIONSHIPS FOR HIGH-ENERGY HEAVY-ION REACTIONS. Bertini, H.W. (Neutron Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830); Larson, N.M. Phys. Rev. C 12: No. 3, 871-876 (Sept 1975).

Established properties of the relativistic intrinsic and orbital angular momentum tensors are reviewed, and relationships between the components of these tensors are derived. These relationships reduce the number of unknowns that must be determined for the calculation of the relativistic spin of the heavy fragments in high-energy heavy-ion interactions, in the limit where quantum mechanics may be ignored. An example using the intranuclear-cascade model is presented. (auth)

4503 OFF-ENERGY-SHELL BEHAVIOR OF THE T MATRIX FOR REALISTIC LOCAL N-N POTENTIALS WITH SOFT OR HARD CORES. Ballot, J.L.; L'Huillier, M.; Benoist-Gueutal, P. (Institut de Physique Nucléaire, Division de Physique Théorique, 91406 Orsay, France). Phys. Rev. C 12: No. 3, 725-740 (Sept 1975).

Off-energy-shell T matrix elements for any partial wave are calculated using realistic local two-nucleon potentials with soft or hard cores. The off-shell behaviors are discussed in relation to on-shell values. Off-shell cross sections involved in the impulse approximation of nuclear reactions are analyzed. The validity of some usual on-shell approximations is examined. (auth)

4504 PROPAGATION IN NONLOCAL OPTICAL POTENTIALS. Lenz, F.; Moniz, E.J. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). Phys. Rev. C 12: No. 3, 909-914 (Sept 1975).

We show that a nonlocal optical potential implies multiple eigenmode propagation. This is important when the mean free path becomes of the order of the nonlocality, such as in the strong absorption situation occurring for pion scattering near the 3-3 resonance, and consequently the propagation cannot be described reasonably by one complex wave number. The eigenmode structure can be seen most directly in quasielastic scattering. (auth)

4505 MECHANISMS CONTRIBUTING TO K ELECTRON EJECTION IN NUCLEAR β DECAY. Law, J. (Physics Department, University of Guelph, Guelph, Ontario, N1G 2W1, Canada); Campbell, J.L. Phys. Rev. C 12: No. 3, 984-996 (Sept 1975).

Theoretical calculations of shake-off and shake-up autoionization probabilities for K electrons are presented, using the formalism presented previously. Total K electron ejection probabilities P_K are obtained by summing shake-off and shake-up contributions. The role of direct collision is discussed. Agreement between these P_K values and 33 recent experimental results produced by different techniques is generally good. The comparison permits critical assessment of the remaining weaknesses of the theory. (auth)

4506 A SHELF IN THE "SUBTHRESHOLD" PHOTOFISSION CROSS SECTION. Bowman, C.D. (National Bureau of Standards, Washington, D. C. 20234). Phys. Rev. C 12: No. 3, 856-862 (Sept 1975).

The influence of a double-humped fission barrier on the photofission cross section far below the top of the barrier is considered. In the region about 2 MeV below the top of the outer barrier and at a cross section in the region of 10^{-9}–10^{-6} b the photofission is expected to become almost entirely isomeric or delayed fission. When this occurs a "shelf" should appear in the photofission cross section where the cross section changes with energy far more slowly than at higher γ-ray energy. The cross section on the shelf can therefore be orders of magnitude higher than otherwise expected. While the angular distribution near the top of the barrier is expected to have a well-defined and nonisotropic angular dependence, the angular distribution on the shelf is expected to be isotropic. The cross sections, although small, appear to be measurable with bremsstrahlung beams in the 3- to 5-MeV range using a several hundred μA electron beam. Successful experiments of this type should provide information on the shape of the inner and outer barriers at much lower excitation energies than possible by other techniques. (auth)

4507 ELECTROSTATIC POTENTIALS FOR NUCLEUS-NUCLEUS OPTICAL MODEL. Jain, A.K.; Gupta, M.C.; Shastry, C.S. (Department of Physics, Birla Institute of Technology and Science, Pilani-333031, India). Phys. Rev. C 12: No. 3, 801-805 (Sept 1975).

The electrostatic potential between nuclei having arbitrary charge distributions is expressed as a triple integral. For two nuclei having uniform distributions, an algebraic expression for the electrostatic potential is obtained. This is then compared with the electrostatic potentials normally used in various nucleus-nucleus optical model calculations. The results of the former are found to be significantly different from the latter. For Fermi-Fermi types of charge distributions, the nuclei may be assumed to be uniformly charged spheres without much loss of accuracy. If one of the charge distributions has either Gaussian or harmonic well shape, the triple integral is reduced to a single integral. For a number of nucleus-nucleus pairs, we have calculated the electrostatic potentials assuming them to be uniformly charged spheres and compared them with those derived from realistic charge distributions. With a proper choice of radius parameters, the former can be used to a good degree of accuracy to generate the electrostatic potential between the nuclei. (auth)

4508 OBSERVATION OF THE RECOIL PROTON IN QUASIELASTIC PION SCATTERING. Silbar, R.R. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544); Stupin, D.M. Phys. Rev. C 12: No. 3, 1089-1092 (Sept 1975).

A semiclassical model is developed to give a first estimate of the expected cross section for observation of the recoil proton in quasielastic pion scattering. Advantages of detecting the proton, rather than the scattered pion, are discussed. (auth)

4509 THE PROBLEM OF THE MAGNETIC MOMENT OF THE DEUTERON. Pokrovskii, Yu.E. (I. V. Kurchatov Institute of Atomic Energy). JETP Lett. 21: No. 10, 285-287 (20 May 1975).

It is shown that, when account is taken of the contributions made to the magnetic moment of the deuteron μ_D by the momentum-dependent terms of the local *NN* potential, it becomes possible to reconcile μ_D with experiment within the framework of the nonrelativistic Pauli theory. The magnetic moment of the deuteron then agrees well with diffraction *D* of the state and wave function of the deuteron P_D=5.5–7%, and does not contradict any other data. (auth)

PHYSICS (RADIATION AND SHIELDING)

Radiation Physics

Refer also to abstracts 3060, 3062, 3066, 3948, 4065, 4292, and 4293.

4510 (CONF-750927-4) DEGRADATION SPECTRA AND IONIZATION YIELDS OF ELECTRONS IN GASES. Inokuti, M.; Douthat, D. A.; Rau, A. R. P. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 33p. Dep. NTIS $4.75.

From 5th symposium on microdosimetry; Varbania Pallanza, Italy (22 Sep 1975).

Progress in the microscopic theory of electron degradation in gases by Platzman, Fano, and co-workers is outlined. The theory consists of (1) the cataloging of all major inelastic-collision cross sections for electrons (including secondary-electron energy distribution in a single ionizing collision) and (2) the evaluation of cumulative consequences of individual electron collisions for the electrons themselves as well as for target molecules. For assessing the data consistency and reliability and extrapolating the data to the unexplored ranges of variables (such as electron energy), a series of plots devised by Platzman are very powerful. Electron degradation spectra were obtained through numerical solution of the Spencer–Fano equation for all electron energies down to the first ionization thresholds for a few examples such as He and Ne. The systematics of the solutions resulted in the recognition of approximate scaling properties of the degradation spectra for different initial electron energies and pointed to new methods of more efficient treatment. Systematics of the ionization yields and their energy dependence on the initial electron energy were also recognized. Finally, the Spencer–Fano equation for the degradation spectra and the Fowler equation for the ionization and other yields are tightly linked with each other by a set of variational principles. (52 references, 7 figures) (DLC)

4511 (EUR–5273d-e-f(Vol.1), pp 287-308) PROBLEMS OF NEUTRON DOSIMETRY ((d,Be) AT 33 AND 50 MeV). Parmentier, N. (CEA, Fontenay-aux-Roses, France); Wambersie, A.; Meulders, J. P.; Ricourt, A. Mar 1975. (In French)

From 2nd symposium on neutron dosimetry in biology and medicine; Neuherberg/Munich, F.R. Germany (30 Sep 1974).

In proceedings of second symposium on neutron dosimetry in biology and medicine. I.

The partially unresolved practical dosimetry problems discussed in the present report appeared during measurements made with the beams of the Louvain-la-Neuve isochronous cyclotron CYCLONE with deuterons accelerated to variable energies up to 50 MeV. The first radiobiological experiences showed some problems in the interpretation of results and their comparison with results obtained by others with other types of beams. These problems can be reduced essentially to the selection of the physical parameters so that comparisons can be made between different beams. The problems considered are determination of the dose absorbed at a point, study of beams in absorbing medium, and microdosimetric parameters and radiobiology. (tr-auth)

4512 (EUR–5273d-e-f(Vol.1), pp 445-452) DOSIMETRY AT THE NEUTRON THERAPY FACILITY AT THE GERMAN CANCER RESEARCH CENTER. Hoever, K. J. (Institut fuer Nuklearmedizin, Heidelberg); Hartmann, G.; Lorenz, W. J.; Menzel, H. G.; Schraube, H.; Wolber, G. Mar 1975.

From 2nd symposium on neutron dosimetry in biology and medicine; Neuherberg/Munich, F.R. Germany (30 Sep 1974).

In proceedings of second symposium on neutron dosimetry in biology and medicine. I.

The cyclotron therapy facility and its gas target and collimator are discussed. The dose monitoring system consisting of a ^{235}U pulse chamber wrapped in cadmium, a ^{238}U fission chamber in the paraffin shielding and a cylindrical tissue equivalent ionization chamber as a primary dose monitor is described. Fast neutron dosimetry was performed using ionization chambers, activation foils and TLD-dosimeters, and microdosimetry was done using a tissue equivalent proportional counter. Results are given for the ionization chamber dosimetry. Tissue kerma for free air, and tissue dose in a phantom are given. Depth dose distribution is shown for a water phantom, with neutron and gamma dose normalized to the neutron dose at 5 cm depth. (2 figs., 1 table) (GHT)

4513 (JUL-1196) INTERNATIONAL INTERCOMPARISON OF NEUTRON SPECTRA EVALUATING METHODS USING ACTIVATION DETECTORS. Fischer, A. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Zentralabteilung Brennelement- und Bestrahlungstechnologie). Jun 1975. 190p. Dep. NTIS (US Sales Only) $12.50.

The International Intercomparison of Neutron Spectrum Evaluation Methods Using Activation Detectors was organized by the IAEA in 1971 - 1972. All of the contributions and the results of a critical evaluation are presented here. The spectra of different contributors are compared to a reference spectrum by means of different integrals and weighting functions. Different cross section sets, foil numbers, energy point systems, guess spectra used by the contributors causes differences in the resulting spectra. The possible ways of separating these effects are also investigated. Suggestions are made for the organization of a new intercomparison on the basis of more uniform input data. (129 figures, 23 references) (auth)

4514 (JUL--1204) ELECTRONIC ENERGY LOSS OF FAST MOLECULES IN MATTER. Steinbeck, J. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Material- und Festkoerperforschung). Jun 1975. 174p. (In German). Dep. NTIS (US Sales Only) $11.75.

Thesis. Submitted to Technische Hochschule, Aachen.

In high velocity collisions of molecular ions the correlated motion influence of the ion cores on the electronic energy loss is investigated. The stopping power in the first Born approximation for a random arrangement of target atoms can be formulated in terms of the inelastic electronic structure factor. In treating the target atoms in Hartree-Fock approximation each electron can be regarded as stopping the ion independent of all other electrons without restriction by the Pauli principle. A second equivalent formulation of the stopping power leads to the dielectric function of the target. The results are applied to the stopping of H_2^+-ions. For vanishing distance between the two protons the stopping power per particle is twice that for single proton collisions. For distances in the order of the Bohr radius the correlated stopping power may even be smaller than for uncorrelated protons. With increasing distances the correlation influence vanishes. The stopping of H_2^+-ions in C, Si and Ge is discussed using Clementi wave functions for the core electrons and a free electron approximation with Lindhard's dielectric function for the valence electrons. The comparison with the only experimental result available for H_2^+ in C at 300 keV yields qualitative agreement. (auth)

4515 (SSI-1975-008) EFFECTS OF SURFACE CURVATURE ON CHARGED PARTICLE EQUILIBRIUM IN TANGENTIAL HIGH-ENERGY PHOTON BEAMS. Ssengabi, J. (Statens Straalskyddsinstitut, Stockholm (Sweden)). Feb 1975. 85p. Dep. NTIS (US Sales Only) $7.25.

Most studies on the electronic build-up in photon beams, have been limited to the use of radiation beams directed normal to the skin or a phantom surface. In tangential irradiation, as in the radiotherapy of carcinoma of the breast or tumours in the neck and skull, the angle of incidence varies from one area to another. The contour may be semi-cylindrical as the chest wall, or almost spherical as the skull, the angle of incidence approaching 90 degrees as the beam strikes the upper-most part of the skin surface. Under these circumstances, it is impossible to estimate the dose distribution in the superficial layers of the skin from published data which apply only to normal incidence. The present investigation programme was designed to obtain more information on the build-up effect at various surface curvature during tangential high energy photon beam irradiation, and also to extend the energy range. In the investigations γ rays from a Cobalt-60 teletherapy unit and the roentgen radiation from a 6MV Varian linear accelerator and a 42 MV Siemens betatron belonging to Radiumhemmet, Karolinska Sjukhuset, Stockholm were used. (auth)

4516 (UCID-16865) THIN FOIL ELECTRON BEAM IMPULSE EXPERIMENTS. Kvam, K. C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 26 Jul 1974. Contract W-7405-Eng-48. 31p. Dep. NTIS $4.75.

Measurements were made of the impulse produced by thin, metallic foils that had been rapidly and uniformly heated in depth, to melt or vaporization by an electron beam. Blowoff predictions were done using two hydrocodes: PUFF, with the GRAY three phase equation of state, and CHART, with its three phase equation of state. An acceptable correlation variable, folding in electron beam and material characteristics, was derived and used successfully to plot and analyze predicted and measured data trends. We conclude that PUFF and CHART, with their present equations of state, predict impulse cor-

rectly within tolerances of +-30 percent. Unfortunately, the lack of repeatability of the electron beam machine precludes its use for doing more accurate equation of state measurements. (9 figs, 5 tables, 10 refs.) (auth)

4517 THE ANALYSIS OF ACCIDENT FACTORS AND ITS APPLICATION. Bocquet, H.; Moreau, J. C.; Perotin, J. P.; Resnier, C. J.; Werderer, B. pp 179-184 of 8th National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French)

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

The general principles for the investigation of accident factors are developed and they are applied to the analysis of an accident case. (FR)

4518 PHOTON DOSIMETRY. Evaluation and Monitoring of Absorbed Dose. Desmettre, J. P.; Lucas, G.; Poulard, S. (CEA Centre d'Etudes de Vaujours, 93 - Sevran (France)). pp 327-341 of 8th National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French)

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

The dose absorbed by the material is estimated from penetration curves (electrons) or isodose curve networks (photons). The characteristics of the linear accelerator used are given, different dosimetric techniques are described and the advantages of computer-assisted dosimetry are mentioned. The use of computing programmes to evaluate dose rate leads to greater precision and appreciable time-saving. It gives excellent results in cobalt therapy and is starting to be used in the field of industrial gamma irradiations for the calculation of isodose curves. The work in progress and the first results obtained are reported. (FR)

4519 IONIZING RADIATION METROLOGY WITHIN THE FRAMEWORK OF THE NATIONAL METROLOGY BUREAU OF STANDARDS. Grinberg, B. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Lab. de Metrologie des Rayonnements Ionisants). pp 369-377 of 8th National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French)

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

Ionizing Radiation Metrology is organized within the more general framework of the National Metrology Bureau (NMB). This latter has a double mission: firstly in each branch of physics it encourages fundamental or applied research on standards and measurement techniques, secondly it guarantees calibration chains by setting up calibration centres and procedures, checked by member laboratories of the NMB federation, to formalise and improve the transfer of precision from the national standard to the commercial measurement instrument. Within this framework, Ionising Radiation Metrology follows three broad lines of action: metrology of activities; metrology in dosimetry; fundamental parameters. The situation in these three sectors is analysed. The various approved laboratories are listed and their role in the ionising radiation calibration chain is defined. (FR)

4520 ION TRAJECTORY CALCULATIONS. Duban, Pierre; Le Grives, Emile (Office National d'Etudes et de Recherches Aerospatiales (ONERA), 92 - Chatillon (France)). Acta Electron.; 17: No. 4, 383-388(Oct 1974). (In French)

A program for the calculation of the trajectories and of the potential field of a linear strip optics (two-dimensional) was set up by the ONERA and a CDC 6600 computer of the CNES. The application of the program is limited at present to the study of a convergent circular form of the emitting surface (ionizer). A method of finite difference is used, the topology of the zone near the emitter being treated by means of an analytical method all the more precise when the variation of the electric field on the emitting surface is smaller. The method of calculation is described. The results, given in the second part, include the distribution of Laplace and Poisson potentials as well as the corresponding deterministic trajectories of the ions, the densities of the electrical charge in the beam and the reference thrust. The calculation times run between 50 and 160 seconds. (FR)

4521 SURFACE IONIZATION THEORY. Bonnal, J.-F.; Pelissier, Andre (Laboratories d'Electronique et de Physique Appliquee (LEP), 94 - Limeil-Brevannes (France)). Acta Electron.; 17: No. 4, 375-382(Oct 1974). (In French)

After a brief theoretical review, the relationship existing between the ionization rate in the vicinity of a metallic plate in thermodynamic equilibrium with a cesium plasma and the density of electron current issued from the same plate is presented. The evolution of this density of current is represented by the Langmuir S-curves. It is shown that knowledge of the S-curves leads to that of the critical temperatures and of the ionization rates when the generated ions are extracted by an electric field. The influence of the principal parameters (the nature and temperature of the plate and the cesium flow supplying it) is analyzed using the Rasor theory. The theoretical results obtained using a model of the flat plate represent fairly closely the operations observed experimentally on porous tungsten ionizers. (FR)

4522 DOSE FROM SCATTERED ROENTGEN RADIATION TO A PROTECTED PART OF A MOUSE PHANTOM. Bojtor, I.; Hiesche, K.; Schnell, P. O. (Kungliga Karolinska Mediko-Kirurgiska Institutet, Stockholm (Sweden)). Acta Radiol., Ther., Phys., Biol.; 13: No. 1, 32-36(1974).

The dose contribution from scattered radiation to a shielded region of a leg in a mouse phantom was determined under specified conditions. It proved to vary between 0.2 and 8% of the maximum delivered to the phantom body. (auth)

4523 CALCULATIONS FOR HIGH-ENERGY RADIATIONS. Turner, J. E.; Wright, H. A.; Hamm, R. N. (Oak Ridge National Lab., Tenn. (USA)). Radioprotection; 9: No. 2, 131-140(1974).

The theoretical high-energy dosimetry program, developed over the past decade in the Health Physics Division of the Oak Ridge National Laboratory, is described briefly. Some selected results are presented to illustrate the calculational capabilities that exist. These examples include depth-dose curves for broad, parallel beams of 2 GeV protons and 1 GeV neutrons incident laterally on a tissue slab and ^{11}C activation calculated as a function of depth in a water phantom exposed to a beam of 400 MeV neutrons. Because of their planned use in cancer radiotherapy research, pions are under extensive study. The Monte Carlo computer code, PION-I was developed to calculate the penetration of pions in materials (containing H, C, N, and O) exposed to pion beams. Good agreement is found between calculated and measured curves in water. Calculated L.E.T. distributions at various depths are shown. The pattern of energy deposition around pion capture sites is analyzed. T-1 kidney cell survival levels are predicted for pion beams based on data of Todd and on the survival model of Katz. (FR)

4524 DOSIMETRY OF ^{192}Ir AND QUANTITATIVE IDENTIFICATION OF ISOMORPHOUS Hg DERIVATIVE IN B-J PROTEIN. Cunningham, D. E. Newark, DE; Univ. of Delaware (1975) 182p. University Microfilms Order No. 75-6387.

Thesis (Ph. D.).

The absorbed dose rate in a tissue equivalent material around an iridium-192 wire was investigated. The dose rates were determined empirically using thermoluminescent dosimeters. Theoretical calculations with a modified Sievert integral substantiated the empirical data. The calculated dose rates were determined by independently evaluating the integrals for each line in the energy spectrum of iridium taking into account self-absorption in the source, absorption in the platinum sheath, and correcting to absorbed dose in tissue. The experiments were performed in four different scattering geometries. A comparison of these results indicated the effects of scattered radiation on the absorbed dose rates. Gamma ray spectroscopy subsequent to radioactivation analysis was used to determine the number of gram atoms of mercury in a Bence-Jones protein. The mercury was synthetically bound to the penultimate half-cystine residue as an isomorphous derivative to facilitate the determination of phases in the primary structure study of the Bence-Jones protein by x ray diffraction. The results indicate that the protein molecules contain between 0.8 and 1.0 gram atoms of mercury per molecule. (Diss. Abstr. Int., B)

4525 THE MICRODOSIMETRY. Numakunai, T. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). Radioisotopes (Tokyo); 23: No. 8, 474-484 (Aug 1974). (In Japanese).

The conception of microdosimetry in the ICRU-Report 19 "Radiation Quantities and Units", 1971, was introduced into a traditional notion of physical quantities for the first time. Now, the examination of these physical quantities, the concrete instances of this application, and future problems are summarized. In the second chapter, fundamental physical quantities defined by ICRU, it shows the definition and the distribution of stochastic quantity, moderation spectrum of charged particles in medium under conditions of which incident radiations are x rays, γ rays, neutrons,

and heavy ion rays, and application to relationship between dose and effect which is the most representative method to express radiation effect quantitatively. As future problems, the development of microdosimetry is expected with regard to introducing the result of analysis of the mechanism of energy transfer and applying to the field of radiation protection. (JA)

4526 CHARACTERISTIC X—RAY PRODUCTION BY ARGON PROJECTILES MOVING IN GRAPHITE TARGETS BETWEEN 30 AND 200 keV. Fortner, R.J. (Lawrence Livermore Laboratory, Livermore, California 94550); Garcia, J.D. Phys. Rev. A 12: No. 3, 856-868 (Sept 1975).

Thick-target yields and x-ray spectra have been measured for argon ions impinging on graphite targets at energies between 30 and 200 keV. The thick-target yields of carbon *K*-shell and argon *L*-shell x rays are analyzed on the basis of a simple model involving multiple collisions and molecular-orbital promotions. The analysis results in average argon *L*-shell fluorescence yields and total decay rates for argon ions traversing the solid. These values are found to be substantially lower than those appropriate to argon ions traversing a gas target. An explanation for the differences is proposed, and found to be corroborated by analysis of the observed x-ray spectra. An approximate determination of the argon *M*-shell vacancy distribution is obtained and compared with beam-foil charge equilibrium measurements. (auth)

4527 ELECTRON-ENERGY-LOSS STUDY OF THE MERCURY CHALCOGENIDES. Katonak, T.T.; Hengehold, R.L. (Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio 45433). J. Appl. Phys. 46: No. 10, 4294-4300 (Oct 1975).

Electron-energy-loss measurements have been made on crystals of HgSe, HgTe, and hexagonal HgS over the energy range 0–50 eV by reflection techniques. The measurements were made using electron-beam energies of 250 to 1000 eV from surfaces obtained by cleavage in ultrahigh vacuum. The resulting spectra showed structure dependent upon surface condition at 8.9, 9.1, and 8.1 eV in HgS, HgSe, and HgTe, respectively. This structure has been associated with surface plasmon excitation. Bulk plasma peaks were observed at 20.8, 17.2, and 14.7 eV and *d*-band transition peaks at 12.3 and 14.1 eV, 10.2 and 12.2 eV, and 10.2 and 11.8 eV, respectively, for HgS, HgSe, and HgTe. The large splitting of these latter peaks allows unambiguous identification as *d*-band transitions. The energies obtained from the energy-loss spectra are compared to those obtained from optical reflectivity and x-ray and uv photoemission. (auth)

4528 MONTE CARLO TREATMENT OF MULTIPLE COULOMB SCATTERING IN PION-BEAM DOSE CALCULATIONS. Hamm, R.N.; Wright, H.A.; Turner, J.E. (Health Physics Division, Holifield National Laboratory, Oak Ridge, Tennessee 37830). J. Appl. Phys. 46: No. 10, 4445-4452 (Oct 1975).

Multiple scattering of negative pions in tissue is investigated by Monte Carlo methods for an 82-MeV pencil beam by using (i) single deflections of each pion at the target surface with straight trajectories thereafter, (ii) successive angular deflections after specified distances of travel in the target, and (iii) successive angular deflections and lateral displacements after specified distances of travel. Results of the computations are compared with results predicted by empirical formulas of Fowler and Perkins for depths of 14 and 18 cm. Method (ii), with a distance of 1 cm between sucessive deflections, appears to give a satisfactory representation of multiple scattering. A calculation of isodose contours for a sample pion beam is made both with and without multiple scattering. As this example shows, multiple Coulomb scattering severely limits the degree to which a concentrated therapeutic dose can be delivered to a localized tumor region. (auth)

4529 MANIFESTATIONS OF THE ELECTRON BINDING ENERGIES IN THE SPECTRA OF INCOHERENTLY SCATTERED GAMMA RAYS. Gavrilov, M.G.; Davydov, A.V. (Institute of Theoretical and Experimental Physics). JETP Lett. 21: No. 10, 267-268 (20 May 1975).

In the spectra of γ rays with energies 412, 482, and 662 keV scattered by Pd, W, and Pb samples, we observed steps at energies lower than the initial values by amounts corresponding to the binding energy of the *K* electrons. This effect is ascribed to participation of the *K* shells in the incoherent scattering of the γ rays. (auth)

Radiation Protection Standards

Refer also to abstract 4939.

4530 ABOUT RBE, QUALITY FACTOR, AND DOSE EQUIVALENT. Wambersie, A. (Louvain Univ. (Belgium)). pp 65-83 of 8th National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French)

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

The concepts of RBE, quality factors and dose equivalent are developed and their field of application is specified. (FR)

4531 HEALTH PHYSICS IN MEDICAL RADIOLOGY INSTALLATIONS. Combes, Rene (Societe France-Controle, 92 - Issy-les-Moulineaux (France)). pp 123-128 of 8th National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French)

From 8th Congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Also published as a journal article in Rayonn. Ionis. Tech. Mes. Prot., Jan 74, (No.1) p. 23-30.

A model for the standardization of the methods of control of medical radiology facilities is developed from measurements and surveys, making it possible to specify a radiation protection plan in accordance with regulations. (FF)

4532 PROBLEMS OF EXPOSURE MEASUREMENT WITH EXTENDED SOURCES. Case of X-ray Fluorescence. Chartier, J. L. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Service Technique d'Etudes de Protection et de Polution atmospherique); Roman, D.; Bazoge, A. (Laboratoire Central des Industries Electriques (LCIE), 92 – Fontenay-aux-Roses (France)). pp 269-309 of 8th National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French).

From 8th congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). For English translation, see: J. Nucl. Instrum. Methods (1974) v. 119 p. 427-44.

A number of problems involved in the measurement of exposure rates in X-ray or gamma-ray beams from extended sources were studied. A mathematical model simulating an experimental device producing practically monoenergetic X-ray beams (X-ray fluorescence method) was developed. The theoretical results were in good agreement with experimental data previously published. From this theoretical analogy, it was possible to determine the influence of various parameters of a free-air ionization chamber, and several corrective coefficients were evaluated and measured. The experiments were performed with a mesh-grid free-air chamber expecially fitted to wide beams. The results were compared with those of cavity chambers used in the same experimental conditions. (FR)

4533 BASIC SAFETY STANDARDS FOR RADIATION PROTECTION AND THEIR APPLICATION TO INTERNAL EXPOSURES. Dousset, M. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Protection). pp 13-22 of Radiobiological Seminar on Internal Contamination. Paris, 18-20 March 1974. Jarry, H. (ed.). Montrouge, France; Societe Francaise de Radioprotection ([nd]). (In French).

From radiobiological seminar on internal contamination; Paris, France (18 Mar 1974). (Societe Francaise de Radioprotection, 92 – Montrouge).

Following a summary of the basic concepts on radiation protection units, the safety standards now in effect in France and those recommended by the International Commission on Radiological Protection (ICRP Publication 9, 1965) to be used as a basis to the next Euratom regulations are developed. (FR)

4534 MPC CALCULATION FOR THE RADIONUCLIDES PRODUCED DURING ACCELERATOR OPERATION. Yamaguchi, C. (National Lab. for High Energy Physics, Oho, Ibaraki, Japan). Health Phys.; 29: No. 3, 393-397(Sep 1975).

In spite of their very short half-lives and/or low radiation energies, quite a number of the radionuclides produced during the operation of the high energy accelerators are to be treated as "unknown" nuclides, since their maximum permissible concentration (MPC) values are not listed in the table of ICRP Publication 2. Legal control values for these radionuclides are too strict, and this imposes unnecessary and difficult problems in the field of the high energy accelerator facilities. For these reasons, MPC values for radionuclides produced during accelerator operations, which are not listed in ICRP Publication 2, have been calculated according to methods of this ICRP publication. The radionuclides for which data are given are: ^{5}He, ^{8}Li, ^{9}Li, ^{11}Be, ^{8}B, ^{10}C, ^{11}C, ^{15}C, ^{16}C, ^{13}N, ^{16}N, ^{17}N, ^{14}O, ^{15}O, ^{19}O, ^{20}O, ^{28}Mg, ^{33}P, ^{36}Cl, ^{37}K, ^{43}Sc, ^{44}Sc, ^{45}Ti, ^{49}V, ^{56}Co, ^{57}Ni, and ^{214}Bi. (UK)

Radiation Source Calibration and Standardization

Refer also to abstracts 3076, 3718, and 4513.

4535 STUDY OF ACTIVITY STANDARD: EUROPIUM 152. Legrand, J.; Morel, J.; Traverse, A. (CEA Centre d'Etudes Nucleaires de Saclay, 91-Gif-sur-Yvette (France). Lab. de Metrologie des Rayonnements Ionisants). Bull. Inf. Bur. Natl. Metrol.; 6: No. 19, 23-30(Jan 1975). (In French).

Europium 152 was choosen as a γ primary standard. The energies and absolute intensities of the γ transitions were determined with precision. The results obtained permit a precise and fast calibration of the Ge-Li spectrometer. (FR)

4536 NEUTRON THERAPY, SOURCES AND COLLIMATORS OF FAST NEUTRONS. Breynat, G.; Bory, P.; Marcie, S.; Pontonnier, M. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Section des Accelerateurs). pp 129-146 of 8th National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French).

From 8th congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

Considering the present performances of neutron sources a collimator allowing the use of 14 MeV neutrons in radiotherapy was studied. (FR)

4537 DUTIES AND EQUIPMENT OF AN IONIZING RADIATION CALIBRATION CENTRE. Le Roy, G. (Laboratoire Central des Industries Electriques (LCIE), 92-Fontenay-aux-Roses (France)). pp 311-325 of 8th National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French).

From 8th congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

The chief mission of an ionizing radiation calibration center is to determine what correction factors should be applied to detectors submitted for testing. To this end the centers possess a number of X and γ photon sources which must be checked against the reference standards held by the primary Laboratory (official laboratory member of the NMB federation). The dosimetry section of the Central Electrical Industry Laboratory for X and γ ionizing radiations and the transfer between primary reference beams and those used to check and calibrate dosimeters are presented, together with a survey of the calibration requested by users. (FR)

4538 STANDARDS AND CALIBRATIONS. Hilaire, Michel (CEA Centre d'Etudes Nucleaires de Saclay, 91-Gif-sur-Yvette (France). Lab. de Metrologie des Rayonnements Ionisants). pp 363-368 of 8th National Congress on the Control of Ionizing radiations. Chatenay-Malabry, France; Association des Techniciens Superieurs en Radioprotection ([nd]). (In French).

From 8th congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

The two complementary activities of the Ionizing Radiation Metrology Laboratory (IRML) are developed: preparation of secondary standards for the calibration of detectors and measurement units on the one hand, and furnishings and studies offered by its calibration center on the other. Several hundred solid, liquid and gaseous standards are available in an activity range between 10^{-3} μCi and 10^{4}Ci, prepared from 80 radionuclides. Some practical examples of application are presented. Special calibration and measurement possibilities are developed in two fields, photon dosimetry and neutron measurements. (FR)

Shielding Calculations and Experiments

4539 (EUR-5335e) γ SHIELDING OF IRRADIATED ^{235}U. Penkuhn, H. (Commission of the European Communities, Ispra (Italy). Joint Research Center). Jun 1975. 42p. Dep. NTIS (US Sales Only) $5.25. EUR FB 150,-.

The γ dose rates from thermal fission products of ^{235}U and of a ^{60}Co source are evaluated in spherical geometry using the transport code PIPE. Irradiation and cooling times range from hours to years. Shield thicknesses up to 40 cm lead, 72 cm iron, 180 cm normal and 140 cm barytes concrete, and 480 cm water are considered. Transformation equations are derived which allow to estimate the effect of different source diameters. (28 tables) (auth)

4540 (ORNL-tr-4007) PROGRAM DLS. Groenefeld. 11 May 1973. Translation by E.G. Silver of Italian articles. 57p. Dep. NTIS $6.00.

Detailed instructions for preparing input and using the code DLS are given. The journal article describing this code was cited in NSA with the abstract number 26: 22189. (RWR)

PHYSICS (THEORETICAL)

General

Refer also to abstracts 4003, 4045, 4213, 4569, and 4596.

4541 (JINR-E2-9098) SOME REPRESENTATIONS OF THE CONFORMAL SUPERALGEBRA. Aneva, B. L.; Mikhov, S. G.; Stoyanov, D. T. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 28p. Dep. NTIS (US Sales Only) $5.00.

A new representation series of the conformal super-algebra is found. It has the advantage of containing together with the scalar superfields the spinor ones. Both are irreducible. The various two-point functions of these fields are calculated, and an invariant measure is found which gives a possibility of constructing an invariant bilinear form for the representations obtained. (auth)

4542 MASS AND CHARGE RENORMALIZATION FOR CLASSICAL PROCESSES WITH A FLUCTUATION-DISSIPATION THEOREM. Deker, U.; Haake, F. (Universität Essen, Fach Physik, 43 Essen, Germany). Phys. Rev. A 12: No. 4, 1629-1637 (Oct 1975).

The fluctuation-dissipation theorem (FDT) valid both for canonical systems in equilibrium and for purely irreversible stochastic processes with detailed balance is shown to imply that the renormalized values of all coefficients in the field equation ("mass" and "charges") are simply related to static cumulants of the field. As a consequence, the problem of determining the static behavior of the system (which reduces to quadratures when the FDT holds) is completely separated from the dynamic problem; the perturbation theory for the time dependence of the two-point cumulant has, if properly renormalized, the full statics of the system incorporated exactly; the renormalized perturbation theory (RPT) will, in general, be much more useful than the unrenormalized one since in contrast to the latter it does not necessarily require the system to be nearly Gaussian. If the nonlinearity in the field equation involves only a quartic charge matrix, the renormalized charge matrix is $C^{(4)}/C^{(2)4}$, where $C^{(2)}$ and $C^{(4)}$ are the static cumulants of order 2 and 4, respectively, whereupon the expansion parameter in the RPT becomes $C^{(4)}/C^{(2)2}$; when the static cumulants are known, the smallness of this expansion parameter (which does not necessarily require $C^{(4)} \simeq 0$, i.e., near-Gaussian statics) can be checked explicitly. The usefulness and necessity of mass and charge renormalization is demonstrated by a perturbative calculation of the linewidth of the Van der Pol oscillator; although this oscillator is far from Gaussian near and above threshold, the result (below, near, and above threshold) is quite satisfactory already in second and excellent in fourth order; the unrenormalized perturbation expansion, on the other hand, yields nonsense in any finite order except very far below threshold where the oscillator is indeed nearly Gaussian. For many-body systems the static cumulants defining the renormalized mass and charge(s) can, in general, not be evaluated exactly; however, in many cases sufficiently accurate approximate values or experimental information are available to render the RPT practical. (auth)

4543 VARIATIONAL *LOWER* BOUND ON THE SCATTERING LENGTH. Rosenberg, L.; Spruch, L. (Physics Department, New York University, New York, New York 10003). Phys. Rev. A 12: No. 4, 1297-1304 (Oct 1975).

The scattering length A characterizes the zero-energy scattering of one system by another. It was shown some time ago that a variational upper bound on A could be obtained using methods, of the Rayleigh-Ritz type, which are commonly employed to obtain upper bounds on energy eigenvalues. Here we formulate a method for obtaining a variational *lower* bound on A. Once again the essential idea is to express the scattering length as a variational estimate plus an error term and then to reduce the problem of bounding the error term to one involving bounds on energy eigenvalues. In particular, the variational lower bound on A is rigorously established provided a certin modified Hamiltonian can be shown to have no discrete states lying below the level of the continuum threshold. It is unfortunately true that necessary conditions for the existence of bound states are not available for multiparticle systems in general. However, in the case of positron-atom scattering the adiabatic approximation can be introduced as an (essentially) solvable comparison problem to rigorously establish the nonexistence of bound states of the modified Hamiltonian. It has recently been shown how the validity of the variational upper bound on A can be maintained when the target ground-state wave function is imprecisely known. Similar methods can be used to maintain the variational lower bound on A. Since the bound is variational, the error in the calculated scattering length will be of second order in the error in the wave function. The use of the adiabatic approximation in the present context places no limitation in principle on the accuracy achievable. (auth)

4544 CLASSICAL LIMIT AND GENERALIZATIONS OF THE HOMOGENEOUS QUASIPOTENTIAL EQUATION FOR SCALAR INTERACTIONS. Crater, H.W.; Naft, J. (Department of Physics and Astronomy, Vanderbilt University, Nashville, Tennessee 37235). Phys. Rev. D 12: No. 4, 1165-1177 (15 Aug 1975).

The classical limit of Todorov's relativistic Schrödinger equation for scalar interactions is presented in a Hamiltonian context. The consequences of limitations on the coupling-constant size that exist in this quantum equation for bound states appear as orbital limitations in the classical case. A systematic method of generalizing the classical equations which removes these orbital restrictions is developed. The corresponding quantum equations do not display any limitations on the coupling-constant size. An exactly soluble example is given that displays very deep binding. In this example the total center-of-mass energy of two equal-mass bound particles goes to zero as the coupling constant goes to infinity. (auth)

4545 THEORY OF *J*-MATRIX GREEN'S FUNCTIONS WITH APPLICATIONS TO ATOMIC POLARIZABILITY AND PHASE-SHIFT ERROR BOUNDS. Heller, E.J. (The James Franck Institute, The University of Chicago, Chicago, Illinois 60637). Phys. Rev. A 12: No. 4, 1222-1231 (Oct 1975).

The recently introduced Jacobi or *J*-matrix techniques for quantum scattering are developed to include the construction of exact analytic matrix elements of regular and Coulomb partial-wave zeroth-order and full Green's functions. Very simple results obtain for the unperturbed Green's functions, while full Green's functions require a single diagonalization of an $N \times N$ Hamiltonian matrix, where N is the number of basis functions coupled by the matrix truncated potential. In an application of the *J*-matrix Green's functions to the theory of atomic dynamic polarizabilities, the analytic result for hydrogen is derived, and it is shown how more general systems may be treated in a way which is superior to the usual N-term variational approach. In an application to error bounds for phase shifts, we show how the full Green's functions can be used to demonstrate the absence of false pseudoresonances in *J*-matrix scattering calculations, and bound the possible errors in computed phase shifts. (auth)

4546 COORDINATE INVARIANCE, THE DIFFERENTIAL FORCE LAW, AND THE DIVERGENCE OF THE STRESS-ENERGY TENSOR. Epstein, S.T. (Theoretical Chemistry Institute and Department of Physics, University of Wisconsin, Madison, Wisconsin 53706). J. Chem. Phys. 63: No. 8, 3573-3574 (15 Oct 1975).

Hermitian operators linear in momenta generate coordinate transformations. The associated hypervirial theorems are written in the form of moments of a differential force law, and a connection is made with the stress-energy tensor of the Schrödinger field in configuration space. (auth)

4547 VIRIAL THEOREM FOR THE JASTROW-TYPE GROUND STATE OF A BOSE FLUID. Hiroike, K. (Tohoku Univ., Sendai (Japan). Faculty of Engineering). Prog. Theor. Phys. (Kyoto); 52: No. 3, 860-870(Sep 1974).

A sufficient condition that the virial theorem should be valid is derived for the Jastrow-type ground state, in which the wave function is a product of pair functions and the pair function is so determined as to minimize the expectation value of the Hamiltonian. It is proved that the virial theorem holds even for the approximate Jastrow-type ground states in which the hyper-netted chain approximation, the Percus-Yevick approximation and the Yvon Born-Green approximation are introduced. (auth)

4548 SELECTED STABLE STATES IN LARGE QUANTUM SYSTEMS. Hatch, D. M. (Brigham Young Univ., Provo, UT). Int. J. Quant. Chem.; 9: No. 4, 649-655 (Jul 1975).

The utility of an infinite number of degrees of freedom is examined in the context of quantum systems. Such systems are known to allow inequivalent representations of the commutation relations, qualitative differentiation (spontaneously broken symmetries) arising from cooperative effects, and superselected stable states. This freedom is discussed and then used in an exactly soluble model of the measurement process. (auth)

4549 UNEQUAL MASS SPINOR-SPINOR BETHE-SALPETER EQUATION. Brennan, B. J. (Univ. of Auckland, New Zealand). J. Math. Phys. (N. Y.); 16: No. 11, 2241-2249(Nov 1975).

Coupled radial equations are derived for the ladder approximation Bethe-Salpeter equation describing a system of two spin-(1/2) particles of unequal masses interacting to form a bound state of total mass zero. The numerical behavior of the coupling parameter lambda as a function of the mass ratio is examined for known analytical equal-mass solutions. In addition a perturbation method is employed to investigate the behavior of lambda for small values of the exchange mass. (auth)

4550 THE WEYL CORRESPONDENCE AND PATH INTEGRALS. Mizrahi, M.M. (Center for Relativity, University of Texas, Austin, Texas 78712). J. Math. Phys. (N.Y.) 16: No. 11, 2201-2206 (Nov 1975).

The method of Weyl transforms is used to rigorously derive path integral forms for position and momentum transition amplitudes from the time-dependent Schrödinger equation for arbitrary Hermitian Hamiltonians. It is found that all paths in phase space contribute equally in magnitude, but that each path has a different phase, equal to 1/h times an "effective action" taken along it. The latter is the time integral of $p\dot{q}-h$ (p,q), h (p,q) being the Weyl transform of the Hamiltonian operator H, which differs from the classical Hamiltonian function by terms of order $\hbar^2$, vanishing in the classical limit. These terms, which can be explicitly computed, are zero for relatively simple Hamiltonians, such as $(1/2M)[P-eA\ (Q)]^2+V\ (Q)$, but appear when the coupling of the position and momentum operators is stronger, such as for a relativistic spinless particle in an electromagnetic field, or when configuration space is curved. They are always zero if one opts for Weyl's rule for forming the quantum operator corresponding to a given classical Hamiltonian. The transition amplitude between two position states is found to be expressible as a path integral in configuration space alone only in very special cases, such as when the Hamiltonian is quadratic in the momenta. (auth)

4551 RARITA-SCHWINGER PARTICLES IN HOMOGENEOUS MAGNETIC FIELDS, AND INCONSISTENCIES OF SPIN-3/2 THEORIES. Seetharaman, M.; Prabhakaran, J.; Mathews, P.M. (Department of Theoretical Physics, University of Madras, Madras-600025, India). Phys. Rev. D 12: No. 2, 458-466 (15 July 1975).

The Rarita-Schwinger equation for a spin-3/2 particle with minimal electromagnetic coupling is solved completely in the case when a constant homogeneous external magnetic field $\mathcal{H}$ is present. It is shown that the spectrum of energy eigenvalues includes complex values if $\mathcal{H}$ is such that $\eta \equiv (2e\mathcal{H}/3m^2) > 1$, and further that the norm of the Rarita-Schwinger wave function (i.e., the total "charge" integral defined from the Lagrangian) which is positive definite for $\eta < 1$ becomes indefinite (even after taking account of the constraints) when η exceeds unity. These results confirm that the difficulties in quantization first discovered by Johnson and Sudarshan are a reflection of the indefiniteness of the norm which appears already at the c-number level, and suggest that the nature of the energy spectrum (whether or not complex values are present) in the presence of very large magnetic fields would provide a quick means of predicting whether such difficulties would arise in quantization. (auth)

4552 PHOTON EMISSION BY AN ELECTRON IN A BICHROMATIC FIELD. Guccione-Gush, R. (4639 West 10th, Vancouver, British Columbia, Canada V6R 2J3); Gush, H.P. Phys. Rev. D 12: No. 2, 404-414 (15 July 1975).

A general expression for the probability of photon emission by an electron in a unidirectional bichromatic classical field is calculated making use of the exact solution to the Dirac equation for the electron in the field. In the limit that one component of the field is weak, a cross section for scattering a photon out of this component is derived. This has a complicated form but numerical values have been obtained in the particular case of an electron of energy 5 GeV travelling through radiation from a ruby laser (considered weak) and an intense CO_2 laser. It is found that, as a function of the intensity of the CO_2 laser, the cross section first increases, but eventually decreases to values below the Compton cross section. The spectrum of the scattered radiation is also calculated; it shows intensity-dependent shifts attributable to a field-induced drift velocity of the electron. (auth)

4553 RELATIVISTIC TIME-OPERATOR CONJUGATED TO THE HAMILTON OPERATOR. Papp, E. (Institutul Politehnic, Cluj); Ionescu-Pallas, N. J. Rev. Roum. Phys.; 20: No. 3, 299-301(1975).

The summarized forms of the hermitic time-operator are analyzed in the coordinate, momentum- and energy representations. It is also proved that at a well defined value of the angular momentum, the hermitic time-operator allows for continuous extension. (auth)

Quantum Field Theories

Refer also to abstracts 3983–3985, 4160, 4161, 4172, 4178, 4214, 4222, 4257, and 4615.

4554 (IC-75/60) RENORMALIZATION GROUP: A GLOBAL APPROACH. Tirapegui, E. (International Centre for Theoretical Physics, Trieste (Italy)). Jun 1975. 62p. Dep. NTIS (US Sales Only) $6.25.

A global approach to renormalization group techniques is presented, based on an invertibility postulate introduced by Jouvet of the transformations of parameters in which a field theory model is described. A case of violation of this postulate on a solvable model is discussed. The relation to the Callan-Symanzik and Gell-Mann-Low analysis is studied in detail, and an interesting possibility of failure of these usual approaches is pointed out; the situation being characterized by $\beta(g) \equiv 0$ and by asymptotic behavior depending on the renormalized coupling constant. Finally the null-mass case is also studied and some anomalous properties of the $g\varphi^4$ model for small g are proved. (auth)

4555 (JINR-P1-9145) INTENSITY OSCILLATIONS IN THE RELATIVISTIC POSITRONIUM BEAMS AND THEIR APPLICATION FOR VERIFICATION OF A SPECIAL THEORY OF RELATIVITY. Nemenov, L. L. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 26p. (In Russian). Dep. NTIS (US Sales Only) $5.00.

The relativistic positronium beams, that are easy to obtain in high energy accelerators, were considered. A schematic diagram of formation and detection of such beams is discussed. The motion of these beams in the magnetic fields of a simple configuration leads to the generation of the intensity oscillation of the beam. This effect allows one to verify the transformations of a special theory of relativity with the relative accuracy of 10^{-4} for the γ-factor values being 10^3 to 10^4. (auth)

4556 (ORO-3992-227) SYMMETRY AND EXACT DYON SOLUTIONS FOR CLASSICAL YANG–MILLS FIELD EQUATIONS. Hsu, J. P.; Mac, E. (Texas Univ., Austin (USA). Center for Particle Theory). Aug 1975. 18p. Dep. NTIS $4.00.

It is shown that the conserved magnetic and electric charges in non-Abelian theories have nothing to do with the Higgs scalars and/or the symmetry structure of the Lagrangian. They are a consequence of the local isospin gauge symmetry. Several exact static dyon solutions to the nonlinear classical field equations are presented in both massless and massive Yang-Mills theories, which possess both electric and magnetic charges. (auth)

4557 SHORT-DISTANCE BEHAVIOR OF THE BETHE-SALPETER WAVE FUNCTION IN THE LADDER MODEL. Guth, A.H. (Department of Physics, Columbia University, New York, New York 10027); Soper, D.E. Phys. Rev. D 12: No. 4, 1143-1164 (15 Aug 1975).

We investigate the short-distance behavior of the (Wick-rotated) Bethe-Salpeter wave function for the two spin-1/2 quarks bound by the exchange of a massive vector meson. We use the ladder-model kernel, which has the same p^{-4} scaling behavior as the true kernel in a theory with a fixed point of the renormalization group at $g \neq 0$. For a bound state with the quantum numbers of the pion, the leading asymptotic behavior is $\chi\ (q^\mu) \sim cq^{-4+\epsilon(g)}\gamma_5$, where $\epsilon\ (g) = 1-(1-g^2/\pi^2)^{1/2}$. Our method also provides the full asymptotic series, although it should be noted that the nonleading terms will depend on the nonleading behavior of the ladder-model kernel. A general term has the form $cq^{-a}(\ln q)^n\phi\ (\hat{q}^\mu)$, where c is an unknown constant, a may be integral or nonintegral, n is an integer, and $\phi\ (\hat{q}^\mu)$ is a representation function of the rotation group in four dimensions. (auth)

4558 BOUND STATES AND THE EFFECTIVE POTENTIAL IN FIELD THEORIES. Haymaker, R.W. (Department of Physics and Astronomy, Louisiana State University, Baton Rouge, Louisiana 70803). Phys. Rev. D 12: No. 4, 1178-1191 (15 Aug 1975).

We calculate the leading contribution to the effective potential, V (ϕ), under the assumptions that there is a deep bound state and the corresponding pole dominates the one-particle irreducible vertices for spin-zero field theories. We find that V has a 3/2-power branch point in the ϕ plane on the real axis. We show that the 3/2 power is due to the fact that $V' = dV/d\phi$ satisfies an algebraic equation quadratic and cubic in V' for the cases considered. In the domain of ϕ for which V is real, the leading pole contribution is negative, allowing for the possibility of an instability in the normal vacuum. (auth)

4559 COMMENT ON "BOSE CONDENSATION IN SUPERCRITICAL EXTERNAL FIELDS". Bawin, M. (Université de Liège, Physique Nucléaire Théorique, Institut de Physique au Sart-Tilman, B-4000 Liège 1, Belgium); Lavine, J.P. Phys. Rev. D 12: No. 4, 1192-1193 (15 Aug 1975).

We point out that the analysis developed by Klein and Rafelski in a recent paper does not apply to the problem they consider, i.e., a spinless particle in an external Coulomb field. Their analysis could only apply to short-range potentials for which, however, it has already been shown that no instability of the vacuum due to pair creation arises. (auth)

4560 COMMENTS ON "BOSE CONDENSATION IN SUPERCRITICAL EXTERNAL FIELDS". Klein, A. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19174); Rafelski, J. Phys. Rev. D 12: No. 4, 1194-1195 (15 Aug 1975).

We agree that our previous analysis does not apply to a spinless particle in an external Coulomb field. We explain why it continues to apply *in toto* for a spinless particle in a short-range external field. We describe in qualitative terms the correct quantization for the Coulomb case, which has not previously appeared in the literature. (auth)

4561 PHYSICAL DEGREES OF FREEDOM IN TWO-DIMENSIONAL QUANTUM ELECTRODYNAMICS. Das, A. (Department of Physics, Visva-Bharati University, Santiniketan-731235, West Bengal, India). Phys. Rev. D 12: No. 4, 1196-1198 (15 Aug 1975).

Starting from a two-dimensional free spinor Lagrangian we arrive at a

theory describing Goldstone bosons. Then, using a theorem by Coleman and the Higgs effect, it is shown that two-dimensional quantum electrodynamics is essentially a theory of massive scalar bosons. (auth)

4562 SELF-STRESS AND RENORMALIZATION GROUP. Manoukian, E.B. (Dublin Institute for Advanced Studies, Dublin 4, Ireland). Phys. Rev. D 12: No. 4, 1199-1200 (15 Aug 1975).

An intimate connection exists between the vanishing of the self-stress of a particle (at rest), as required by Lorentz covariance, and a unique normalization of a universal function, of relevant coupling constants in the theory in modern renormalization-group equations. This connection leads, unambiguously, to a correct version of the classic Pais-Epstein result for the self-stress in a self-consistent manner. (auth)

4563 PERTURBATION EXPANSION AROUND EXTENDED-PARTICLE STATES IN QUANTUM FIELD THEORY. Gervais, J. (Laboratoire de Physique Théorique de l'Ecole Normale Supérieure, 24 rue Lhomond, 75005 Paris); Jevicki, A.; Sakita, B. Phys. Rev. D 12: No. 4, 1038-1051 (15 Aug 1975).

The quantum mechanics of solitary-wave classical solutions of nonlinear wave equations is discussed in detail for the kink solution of two-dimensional ϕ^4 field theory. The formalism provides a natural interpretation of an extended particle, the *soliton*, for the classical kink. The perturbation theory around the extended particle is developed and used to calculate the radiative corrections for the mass of soliton up to one loop. The mass renormalization is discussed in detail to show that the mass counterterm to the nonsoliton sector also does the job for the present case, i.e. one-soliton sector. Although our formalism is not manifestly Lorentz-covariant, the Lorentz covariance is shown explicitly by calculating the soliton energy for a fixed momentum. The paper also contains the perturbation calculation of matrix element of ϕ fields between one-soliton states. (auth)

4564 QUANTUM FLUCTUATIONS IN A ϕ^4 FIELD THEORY: I. STABILITY OF THE VACUUM. Chang, S. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). Phys. Rev. D 12: No. 4, 1071-1088 (15 Aug 1975).

We study the effect of quantum fluctuations in a ϕ^4 field theory using a Hartree-type approximation. We reduce the operator field equations into a set of coupled c-number (infinite in number) equations. We show that these equations can also be derived from a variational principle. We carry out the renormalization procedure in the one-dimensional theory in detail and demonstrate how the renormalization can be done in a fashion consistent with the Hartree approximation. We then apply the technique to study the effective potential and the stability of the vacuum. We find that the abnormal vacuum is unstable as the coupling becomes strong, and a transition between the abnormal ($\langle\phi\rangle \neq 0$) and the normal ($\langle\phi\rangle = 0$) vacua occurs in both the one- and the three-dimensional theory. A generalization of the theory to include internal symmetries is briefly outlined. (auth)

4565 GENERALIZED CALLAN-SYMANZIK EQUATIONS AND THE RENORMALIZATION GROUP. MacDowell, S.W. (Yale University, and Pontificia Universidade Catolica do Rio de Janeiro, Brazil). Phys. Rev. D 12: No. 4, 1089-1092 (15 Aug 1975).

A set of generalized Callan-Symanzik equations derived by Symanzik, relating Green's functions with an arbitrary number of mass insertions, is shown to be equivalent to the new renormalization-group proposed by S. Weinberg. (auth)

4566 FERMIONS IN YANG-MILLS POTENTIALS. Swank, J.H.; Swank, L.J.; Dereli, T. (Department of Physics, Yale University, New Haven, Connecticut 06520). Phys. Rev. D 12: No. 4, 1096-1102 (15 Aug 1975).

It is shown that the magnetic monopole of 't Hooft and an isospinor fermion do not have any bound states. Further, the dyon of Julia and Zee considered as a fixed field configuration does not bind an isospinor fermion. An example is given of an infinite-energy solution of the pure Yang-Mills theory which when taken as a potential in a wave equation will confine the wave function. (auth)

4567 GENERAL-RELATIVISTIC QUANTUM FIELD THEORY: AN EXACTLY SOLUBLE MODEL. Candelas, P.; Raine, D.J. (Department of Astrophysics, University of Oxford, South Parks Road, Oxford, England). Phys. Rev. D 12: No. 4, 965-974 (15 Aug 1975).

The massive scalar and Dirac fields quantized on a de Sitter background geometry prove to be exactly soluble models in general-relativistic field theory. The Feynman Green's function is computed for both the scalar and Dirac fields. A dimensional regularization procedure applied in coordinate space facilitates the calculation of their respective effective Lagrangians, which describe the vacuum corrections due to closed matter loops. The model is found to be renormalizable. There is no creation of real particle pairs. (auth)

4568 EFFECTIVE POTENTIAL OF A NON-ABELIAN SUPERSYMMETRIC THEORY. Woo, G. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). Phys. Rev. D 12: No. 4, 975-978 (15 Aug 1975).

The effective potential of a non-Abelian supersymmetric theory with internal isospin symmetry is considered. In the one-loop approximation it is shown that the potential is finite without renormalization, and that where it is not zero, it is complex. In two loops, as in one loop, it is shown that the effective potential of the scalar fields alone vanishes identically. Implications of these results are discussed with reference to possible spontaneous symmetry breaking. (auth)

4569 THE RENORMALIZATION GROUP: CRITICAL PHENOMENA AND THE KONDO PROBLEM. Wilson, K.G. (Laboratory of Nuclear Studies, Cornell University, Ithaca, New York 14850). Rev. Mod. Phys. 47: No. 4, 773-840 (Oct 1975).

This review covers several topics involving renormalization group ideas. The solution of the *s*-wave Kondo Hamiltonian, describing a single magnetic impurity in a nonmagnetic metal, is explained in detail. See Secs. VII–IX. "Block spin" methods, applied to the two dimensional Ising model, are explained in Sec. VI. The first three sections give a relatively short review of basic renormalization group ideas, mainly in the context of critical phenomena. The relationship of the modern renormalization group to the older problems of divergences in statistical mechanics and field theory and field theoretic renormalization is discussed in Sec. IV. In Sec. V the special case of "marginal variables" is discussed in detail, along with the relationship of the modern renormalization group to its original formulation by Gell-Mann and Low and others. (auth)

4570 INTRODUCTION TO THE TECHNIQUE OF DIMENSIONAL REGULARIZATION. Leibbrandt, G. (Department of Mathematics and Statistics, University of Guelph, Guelph, Canada). Rev. Mod. Phys. 47: No. 4, 849-876 (Oct 1975).

The purpose of this review article is to explain and illustrate in detail the technique of dimensional regularization, which is a major mathematical tool in the renormalization program of gauge theories. The most important single feature of the new technique is the concept of analytic continuation in the number of space–time dimensions 2ω, where the regulating parameter ω is complex in general, and $\omega = 2$ corresponds to four-dimensional space–time. The technique of dimensional regularization preserves the local gauge symmetry of the underlying Lagrangian and thereby permits a consistent gauge-invariant treatment of divergent Feynman integrals to all orders in perturbation theory. The method can thus be applied—as demonstrated in this article—not only to Abelian gauge models, but more importantly to non-Abelian theories such as Yang–Mills fields and quantum gravity, to which the majority of conventional regularization procedures is inapplicable. We illustrate both the advantages and the limitation of dimensional regularization, as well as its extension to massless particles. (auth)

4571 DYNAMICAL REARRANGEMENT OF SYMMETRY. Vitiello, G. Milwaukee; Univ. of Wisconsin (1974). 208p. University Microfilms Order No. 75-17,814.

Thesis (Ph. D.).

In quantum field theory, the invariance of the theory is expressed as the invariance of field equations under certain transformations of Heisenberg fields. Since one is interested in physically relevant entities, one is faced with the problem of how the original invariance of the theory manifests itself at the level of observable (physical) particles. This is the problem studied. (Diss. Abstr. Int., B)

4572 PARAFERMI FIELD THEORY AND ELEMENTARY PARTICLES. Ohnuki, Y. (Alberta Univ., Edmonton (Canada). Theoretical Physics Inst.); Kamefuchi, S. Prog. Theor. Phys. (Kyoto); 52: No. 4, 1369-1375(Oct 1974).

A model of elementary particles based on parafermi field theory is discussed. Urbaryons (that constitute hadrons) and leptons are assumed to be described by parafermi fields of p = odd and p = 2, respectively (p: order), and the theory is subject to the minimal gauge group $O(p)_h \times SO(2)_l$. It is emphasized that the existence of the gauge group is a natural consequence of the locality condition of the theory. (auth)

4573 NEUTRAL-VECTOR FIELDS THEORY WITH INVARIANT GAUGE FAMILIES. Yokoyama, K. (Hiroshima Univ., Takehara (Japan). Research Inst., for Theoretical Physics). Prog. Theor. Phys. (Kyoto); 52: No. 5, 1669-1686(Nov 1974).

By a generalization of canonical quantum electrodynamics with invariant one-parameter gauge families, a wide theory of neutral vector fields is formulated in a unified way that described massive and massless fields on the same basis. Similarly to the case of quantum electrodynamics, there exist two invariant gauge families in the sense that any two gauges belonging to the same family are connected with each other by a generalized q-number gauge transformation. It is shown that the theory is manifestly renormalizable and the unitarity of the S-matrix is guaranteed by conservation of currents. Renormalization problems in this formalism are investigated. (auth)

4574 A QUANTUM-THEORETICAL LAGRANGIAN FORMALISM FOR QUASI-LINEAR FIELD THEORIES, 1. General Theory. Okabayashi, T.; Kikugawa, H. (Tokyo Univ. (Japan). Dept. of Physics). Prog. Theor. Phys. (Kyoto); 52: No. 5, 1687-1701 (Nov 1974).

A quantum-theoretical lagrangian formalism for quasi-linear field theories is proposed. Quasi-linear fields are defined by the following conditions: (i) The coefficient of the term involving the highest order of derivative of the field in the lagrangian density is not a constant but a regular matrix function of the field. (ii) In quantum field theories the divergence of the energy-momentum and the angular-momentum tensor density operators are zero or at most space-derivatives of some operators. The preferred fields in the nonlinear realization and pion field interacting with itself through the current-current interaction are typical examples of quasi-linear fields. The present formalism is devised to be able to reproduce all results that have been achieved in the quantum field theory of nonlinear realization based on the characteristics of displacement operators in Minkowski space. However, the variation method proposed has a form which can be applied also to general quasi-linear fields. The points in the present formalism are in the order of operators in the quantum-theoretical "covariant" derivatives and in throwing away the virtual variation technique which seems not to work in quantum theories of quasi-linear fields. (auth)

4575 ASYMPTOTIC BEHAVIOR OF THE GREEN FUNCTION IN A SOLVABLE FIELD THEORY. Sakamoto, J. (Osaka Univ., Toyonaka (Japan). Dept. of Physics). Prog. Theor. Phys. (Kyoto); 52: No. 2, 647-658(Aug 1974).

It is shown in the Lee model that the asymptotic behavior of the Green function obtained from the renormalization group equation and that from the Callan-Symanzik equation coincide with each other and these results also coincide with the exact expression in the high energy region. It is also proved that the Callan–Symanzik equation is included as a particular case of the renormalization group equation; namely, the former can be derived from the latter by a particular choice of parameters in the latter equation. (auth)

4576 THE $\lambda\phi^4_3$ EUCLIDEAN QUANTUM FIELD THEORY IN A PERIODIC BOX. Park, Y.M. (Department of Mathematics, Yonsei University, Seoul, Korea). J. Math. Phys. (N.Y.) 16: No. 11, 2183-2188 (Nov 1975).

The ultraviolet cutoff (the lattice cutoff) normalized Schwinger functions converge as the ultraviolet cutoff (the lattice cutoff) is removed. The limit Schwinger functions are the moments of the normalized physical measure. As a consequence of the lattice approximation, the Lee–Yang theorem and various correlation inequalities hold for the $\lambda\phi^4_3$ field theory in a periodic box. (auth)

4577 ON FINITE MASS RENORMALIZATIONS IN THE TWO-DIMENSIONAL YUKAWA MODEL. Seiler, E. (Institute for Advanced Study, Princeton, New Jersey 08540); Simon, B. J. Math. Phys. (N.Y.) 16: No. 11, 2289-2293 (Nov 1975).

In the Mathews–Salam formulas for the (space–time cutoff) Schwinger functions of Y_2, no restriction on finite mass renormalizations for the boson is necessary. (auth)

4578 NORMAL COORDINATES AND QUANTIZATION OF NONLINEAR FIELDS BY FEYNMAN'S PATH INTEGRAL. Hsue, C.S. (Institute of Physics, National Tsing Hua University, Hsin-Chu, Taiwan, Republic of China). J. Math. Phys. (N.Y.) 16: No. 11, 2326-2327 (Nov 1975).

A simple derivation for the quantization of nonlinear fields by Feynman's path integral method is given in terms of normal coordinates. The origins of the additional term obtained by DeWitt can be clearly seen in this formalism. (auth)

4579 DIELECTRIC RESPONSE OF THE CHARGED BOSE GAS IN THE RANDOM-PHASE APPROXIMATION. Hore, S.R.; Frankel, N.E. (School of Physics, University of Melbourne, Parkville, Victoria 3052, Australia). Phys. Rev. B 12: No. 7, 2619-2628 (1 Oct 1975).

A closed form for the dielectric function of a charged Bose gas is found in the random-phase approximation. This dielectric constant is used to explore the quasiparticle energy spectrum (i.e., the allowed modes of oscillation of the gas), the damping of these quasiparticles, and the long-ranged form of the electrostatic potential around a test charge in the gas. We do this around the three temperature regions of interest; namely, $T=0$, $T=\infty$, and $T=T_c$, where T_c is the transition temperature of the gas. (auth)

4580 RENORMALIZABLE MASSIVE YANG-MILLS THEORY WITH INTRINSIC SYMMETRY BREAKDOWN. Hsu, J.P.; Underwood, J.A. (Center for Particle Theory, The University of Texas, Austin, Texas 78712). Phys. Rev. D 12: No. 2, 620-625 (15 July 1975).

We use the method of the Lagrange multiplier field to construct, within the framework of indefinite-metric field theory, a model of a massive Yang-Mills field, the mass of which derives from an *intrinsic* symmetry breakdown, rather than a spontaneous symmetry breakdown. The rules for the Feynman diagrams are given. The dynamical structure of the interacting fields is intrinsically related to a local non-Abelian gauge symmetry which renders the theory renormalizable by standard power counting. The part of the amplitude due to the interaction of unphysical particles in the intermediate states, which violates unitarity and gauge symmetry, is isolated and removed, leaving the unitary physical S matrix. The unitarity of the resulting theory, together with its independence with respect to the parameter ξ, is demonstrated in calculations at the one-loop and the two-loop levels. (auth)

4581 TRACE AND WARD-TAKAHASHI IDENTITY ANOMALIES IN AN SU(3) CURRENT MODEL WITH ENERGY-MOMENTUM TENSOR. Zacrep, D.B.; Young, B. (Ames Laboratory-ERDA and Department of Physics, Iowa State University, Ames, Iowa 50010). Phys. Rev. D 12: No. 2, 513-522 (15 July 1975).

We discuss the validity of the naive Ward-Takahashi identities and trace identities for arbitrary n-point functions (n-pf's) of scalar, pseudoscalar, vector, and axial-vector currents and the improved energy-momentum tensor, thus extending the previous investigations in a unified way. We show that the validity of the naive Ward-Takahashi identities of the energy-momentum tensor implies the satisfaction of those of the vector currents. This removes an ambiguity concerning the minimal sets of anomalous current Ward-Takahashi identities. We find that all the anomalous Ward-Takahashi identities for the broad structure of n-pf's are again restricted to the axial-vector current of n-pf's of abnormal parity in a well-defined pattern, and the trace identity anomalies occur only in normal-parity n-pf's. We give all these anomalies. Our results show that there are no new anomalies associated with the inclusion of the energy-momentum tensor in the n-pf's. (auth)

4582 EXTENDED PARTICLES AND MAGNETIC CHARGES. Patrascioiu, A. (Institute for Advanced Study, Princeton, New Jersey 08540). Phys. Rev. D 12: No. 2, 523-530 (15 July 1975).

It is shown that in more than two space dimensions a field theory having no massless particles cannot have solutions of the field equations which are periodic in time, have finite energy, and are separated from the vacuum by an infinite potential barrier. In three space dimensions an infinite potential barrier can exist only between solutions with different magnetic charge. In any gauge theory in three space dimensions the magnetic charge is shown to have an intrinsic topological nature. The group $SU(n)$ is analyzed in detail and shown to have $n-1$ types of magnetic charges. The infinite nature of the potential barrier is shown to be relevant for the semiclassical approximation to the path-integral quantization. (auth)

4583 GAUGE FIELDS IN NONLINEAR GROUP REALIZATIONS INVOLVING TWO-DIMENSIONAL SPACE-TIME SYMMETRY. Machacek, M.E.; McCliment, E.R. (Department of Physics and Astronomy, The University of Iowa, Iowa City, Iowa 52242). Phys. Rev. D 12: No. 2, 531-537 (15 July 1975).

It is shown that gauge fields may be consistently introduced into a model Lagrangian previously considered by the authors. The model is suggested by the spontaneous breaking of a Lorentz-type group into a quasiphysical two-dimensional space-time and one internal degree of freedom, loosely associated with charge. The introduction of zero-mass gauge fields makes possible the absorption via the Higgs mechanism of the Goldstone fields that appear in the model despite the fact that the Goldstone fields do not transform as scalars. Specifically, gauge invariance of the Yang-Mills type requires the introduction of two sets of massless gauge fields. The transformation properties in two-dimensional space-time suggest that one set is analogous to a charge doublet that behaves like a second-rank tensor in real four-dimensional space time. The other set suggests a spin-one-like charge triplet. Via the Higgs mechanism, the first set absorbs the Goldstone fields and acquires mass. The second set remains massless. If massive gauge fields are introduced, the associated currents are not conserved and the Higgs mechanism is no longer fully operative. The Goldstone fields are not eliminated, but coupling between the Goldstone fields and the gauge fields does shift the mass of the antisymmetric second-rank-tensor gauge field components. (auth)

4584 ASYMPTOTIC FREEDOM OF YANG-MILLS FIELDS IN THE COULOMB GAUGE. Ali, A.; Bernstein, J. (Centro de Investigación del IPN, Apdo Postal 14-740, México 14, D.F.); Zepeda, A. Phys. Rev. D 12: No. 2, 503-507 (15 July 1975).

We show that the slope of β (g) at the origin is negative in the Coulomb gauge and agrees with the result obtained in covariant gauges. We also make a detailed comparison between the results obtained from the Bjorken-Johnson-Low limit and perturbation theory for the Yang-Mills propagator. (auth)

4585 INFRARED DIVERGENCE OF QUANTUM ELECTRODYNAMICS AT FINITE TEMPERATURE. Eimerl, D. (Department of Physics, University of California, San Diego, La Jolla, California 92037). Phys. Rev. D 12: No. 2, 427-442 (15 July 1975).

It is proved that the necessary and sufficient condition for cancellation of the infrared divergence at finite temperature is that it cancel in vacuo. The specified c-number current problem provides a theoretical laboratory to study the effects of stimulation and is solved exactly at finite temperature. The methods of finite-temperature field theory are used to extract the infrared divergence of quantum electrodynamics at finite temperature to all orders in α. The potential

divergence is promoted by stimulation from logarithmic to an inverse power in k_{min}. As a by-product, the Ward identities and renormalization constants of finite-temperature field theory are obtained. Approximate expressions for the radiative corrections at finite temperature are given. (auth)

4586 QUARK BAGS AND LOCAL FIELD THEORY. II. CONFINEMENT OF FERMI AND VECTOR FIELDS. Creutz, M. (Brookhaven National Laboratory, Upton, New York 11973); Soh, K.S. Phys. Rev. D 12: No. 2, 443-447 (15 July 1975).

We extend earlier work on obtaining the "bag" model of Chodos, Jaffe, Johnson, Thorn, and Weisskopf as a limit of a local field theory. As before, the discussion is on a classical level. We show how to confine Fermi and vector fields into the bag solutions found previously. In an appropriate limit we obtain exactly the Chodos *et al.* model for confinement of all fields except non-Abelian gauge fields. For the latter fields we argue that it is impossible from a local theory to obtain the same boundary conditions used in the Chodos *et al.* model. The boundary conditions we find do not have the virtue of completely eliminating "color" nonsinglet states from the theory. We propose an alternative scheme based on a single triplet of quarks and an Abelian gauge field. The baryons are bound states of three quarks and one additional scalar constituent. (auth)

4587 $1/N$ EXPANSION AS A LOOP EXPANSION. Root, R.G. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts). Phys. Rev. D 12: No. 2, 448-457 (15 July 1975).

The $1/N$ expansion of the effective action of the $O(N)$ model is formulated as a loop expansion. Three variations of the expansion are given: one which requires the fewest graphs for a given order, one in which the power of $1/N$ coincides with the number of loops, and one which does not involve mixed propagators and which is easily applied to the study of the complete effective action. (auth)

4588 WARD IDENTITIES AND SOME CLUES TO THE RENORMALIZATION OF GAUGE-INVARIANT OPERATORS. Kluberg-Stern, H.; Zuber, J.B. (Service de Physique Théorique, Centre d'Etudes Nucléaires de Saclay, BP No. 2-91190 Gif-sur-Yvette, France). Phys. Rev. D 12: No. 2, 467-481 (15 July 1975).

The problem of the renormalization of gauge-invariant operators in the non-Abelian Yang-Mills theory is tackled through the study of a specific example, $\vec{F}_{\mu\nu}{}^2$, for which the explicit solution can be derived from renormalization-group considerations. It is shown that the operator $\vec{F}_{\mu\nu}{}^2$ mixes with non-gauge-invariant operators and that this mixing must be taken into account for the computation of the anomalous dimension of the renormalized gauge-invariant operator. The explicit solution is examined with the help of Ward identities derived from a new type of gauge transformations which appear very convenient from a technical point of view. The multiplicatively renormalizable gauge-invariant operator is shown to satisfy Ward identities and to possess an α-independent anomalous dimension. As a by-product, we analyze the gauge dependence of the Callan-Symanzik function β. (auth)

4589 RENORMALIZATION OF NON-ABELIAN GAUGE THEORIES IN A BACKGROUND-FIELD GAUGE. I. GREEN'S FUNCTIONS. Kluberg-Stern, H.; Zuber, J.B. (Service de Physique Théorique, Centre d'Etudes Nucléaires de Saclay, BP No.2 — 91190 Gif-sur-Yvette, France). Phys. Rev. D 12: No. 2, 482-488 (15 July 1975).

The renormalization of non-Abelian gauge theories is studied in the background-field gauge by means of Ward-Slavnov identities derived from supergauge transformations and with use of 't Hooft and Veltman's renormalization. As a result, the counterterm depending on the background field only is shown to be $(g/g_0)^2 \mathcal{L}(\vec{A}^{cl})$. (auth)

4590 SEARCH FOR ALL RENORMALIZABLE INTERACTIONS. Levin, D.N.; Tiktopoulos, G. (Department of Physics, University of California, Los Angeles, California 90024). Phys. Rev. D 12: No. 2, 415-420 (15 July 1975).

This paper is a continuation of a systematic search for all renormalizable interactions of heavy vector bosons. It is argued that in any renormalizable theory the S matrix must satisfy high-energy unitarity bounds in the tree approximation. In an earlier work it was shown that any massive vector interaction, containing four or fewer boson fields and derivatives in each term, is unitarily bounded at high energy if and only if it is equivalent to a spontaneously broken gauge theory (modulo Abelian vector mass terms). In this paper unitarity bounds are imposed on a general Lagrangian which contains any number of fields (vector and scalar) and derivatives. We show that such an interaction is unitarily bounded only if it is canonically equivalent to an interaction with three-field vertices of mass dimension less than or equal to 4. This result lends further support to the notion that gauge theories are the only renormalizable theories of vector particles and that the appearance of Lie groups of internal symmetries in particle physics can be traced to the requirement of renormalizability. (auth)

4591 SPIN-1/2 QUANTUM FIELD THEORY IN SCHWARZSCHILD SPACE. Boulware, D.G. (Physics Department, University of Washington, Seattle, Washington 98195). Phys. Rev. D 12: No. 2, 350-367 (15 July 1975).

The theory of a quantized Dirac field in the maximal analytic extension of the Schwarzschild metric is presented. The wave equation and its properties under the continuous and discrete symmetries are reviewed, the Green's function is constructed, and the vacuum state so defined is shown to be stable. The excitations of the system are exhibited and the reduction formulas for the states are given. (auth)

4592 GRADIENT PROPERTIES OF THE RENORMALISATION GROUP EQUATIONS IN MULTICOMPONENT SYSTEMS. Wallace, D.J.; Zia, R.K.P. (Department of Physics, The University, Southampton SO9 5NH, England). Ann. Phys. (N.Y.) 92: No. 1, 142-163 (July 1975).

The existence of a metric, which enables the renormalisation group β functions of a multicomponent field theory to be written as a gradient, has very important implications for the asymptotic behavior of the renormalisation group equations. It is shown that a very simple metric exists in a field theory with n-component Bose fields and arbitrary ϕ^4 interaction, when the β functions are calculated perturbatively up to and including the 2-loop diagrams. This same metric is shown to work for *all* irreducible diagrams, but it must and can be modified to accommodate reducible 3-loop contributions. The prospects and outlook of this aspect of the renormalisation group are discussed. (auth)

4593 AN EIKONAL PERTURBATION THEORY HAVING APPLICATIONS IN HADRON DYNAMICS. II. MASSIVE QUANTUM ELECTRODYNAMICS. Orzalesi, C.A. (Istituto di Fisica, Università di Parma, Parma and Istituto Nazionale di Fisica Nucleare, Sezione di Pavia, Pavia, Italy). Ann. Phys. (N.Y.) 92: No. 1, 44-94 (July 1975).

An eikonal perturbation theory (EPT), derived in previous work for a superrenormalizable coupling, is here developed for massive quantum electrodynamics (MQED) involving scalar or spinor matter fields minimally coupled to neutral massive vector gluons. After summarizing the functional method, we present the EPT for the external field problem. In agreement with results known within ordinary perturbation theory (OPT) in the eikonal approximation (EA), from an exact eikonal equation derived here we show that the EPT for the external field problem provides an excellent approximation method for Green's functions at large momenta. We then discuss some general features of the EPT for MQED, and show that it leads to a renormalizable approximation method. Our approach is then illustrated by deriving explicit expressions for various renormalized Green's functions in lowest order EPT. We also discuss some asymptotic properties of such Green's functions and indicate how to proceed with calculations in higher orders. As in our previous work, we again find that the renormalization procedure in EPT bears close resemblance to the one for OPT. Contrary to what happens with the EA, the inclusion of self-interactions and of other field-theoretic effects does not spoil the virtues of the EPT as a far better high-momenta approximation than the OPT. As a typical example, if s is an energy parameter and g the coupling constant with $g^2/4\pi < 1$, OPT to order g^{2n} often fails to be a good approximation as soon as $(g^2/4\pi)\ln s \sim 1$, while in such cases EPT to order g^{2n} is still a good approximation as long as $(g^2/4\pi)^{n+1} \ln s < 1$. We also find that the EPT is superior to the EA in that, contrary to the EA, it provides a step-by-step rigorous and renormalizable iterative approximation method which can account for self-interactions and other field-theoretic effects. We emphasize that the EPT is much simpler and more general than other explicit approximate summation methods of classes of OPT Feynman graphs. In field theory, we consider the use of the EPT as a generalization of the EA for discussing, e.g. high-energy behaviors in MQED as well as infrared divergence and bound-state problems in the limit of massless gluons. It is also suggested that, in view of its nice field-theoretic and high-energy properties, the EPT for MQED might provide a useful laboratory where ideas and problems in hadron dynamics could be meaningfully investigated within a Lagrangian field theory. (auth)

Gravitation and General Relativity

Refer also to abstracts 3740, 3745, 3753, 3868, and 4567.

4594 (CONF-720133-4, pp 93-108) LORENTZ INVARIANCE AND THE β-ALGEBRA OF RELATIVISTIC WAVE EQUATIONS DESCRIBING MASSIVE PARTICLES WITH A GIVEN SPIN. Saavedra, I. (Univ. of Chile, Santiago). 1972.

From 4th symposium on theoretical physics; Rio de Janeiro, Brazil (4 Jan 1972).

In IV Brazilian symposium on theoretical physics. Volume XI.

The connection between the Lorentz invariance of general relativistic wave equations and the angular momentum operators J, and also some of the applications of the resulting formalism are discussed. (JFP)

4595 SCATTERING AND ABSORPTION OF ELECTROMAGNETIC WAVES BY A SCHWARZSCHILD BLACK HOLE. Fabbri, R. (Istituto di Fisica Superiore, University of Florence, Italy). Phys. Rev. D 12: No. 4, 933-942 (15 Aug 1975).

The scattering and absorption of electromagnetic waves by a spherically symmetric nonrotating black hole is studied in the

Schwarzschild background, by means of the known expansion of the modified Debye potentials in partial waves. The power reflection coefficients and the phase shifts of the partial waves are evaluated at both high and low frequencies. Then the scattering and absorption cross sections of the black hole are determined. It is shown that the black hole is almost unable to absorb electromagnetic waves when the wavelength of the radiation is greater than the Schwarzschild radius. (auth)

4596 CLASSICAL LIMIT OF RELATIVISTIC POSITIVE-ENERGY THEORIES WITH INTRINSIC SPIN. Staunton, L.P. (Department of Physics, Drake University, Des Moines, Iowa 50311); Browne, S. Phys. Rev. D 12: No. 4, 1026-1037 (15 Aug 1975).

The classical (nonquantum) relativistic differential equations obtained from positive-energy relativistic wave equations in the correspondence limit are analyzed. The essential role of the Majorana representation of SO(3,2) in the known examples is expounded, and a translation of this role into constraints on the classical-limit motion is developed. It is found that the quantum interpretation of these theories in terms of composite models of elementary particles has a natural analog on the classical level. The structural constituents are found to be massless and to undergo a classical *Zitterbewegung* consisting of a planar corotation whose amplitude and frequency depend on the spin of the quantum state from which the limit was taken. This motion is exactly that which would be described, at the classical level, as the rigid rotation of a massless "string" whose ends achieve the velocity of light. The model serves to define a relativistic, nonquantum intrinsic spin. (auth)

4597 COMPLEX MANIFOLDS IN RELATIVITY. Flaherty, E. J. Jr. Austin, TX; Univ. of Texas (1975). 274p. University Microfilms Order No. 75-16,672.

Thesis (Ph. D.).

Complex manifold theory is applied to the study of certain problems in general relativity. The first half of the work is devoted to the mathematical theory of complex manifold. Then a brief review of general relativity is given. It is shown that any spacetime admits locally an almost Hermitian structure, suitably modified to be compatible with the indefinite metric of spacetime. This structure is integrable if and only if the spacetime admits two geodesic and shearfree null congruences, thus in particular if the spacetime is type D vacuum or electrified. The structure is "half-integrable" in a suitable sense if and only if the spacetime admits one geodesic and shearfree null congruence, thus in particular for all algebraically special vacuum spacetimes. Conditions for the modified Hermitian spacetime to be Kahlerian are presented. The most general metric for such a modified Kahlerian spacetime is found. It is shown that the type D vacuum and electrified spacetimes are conformally related to modified Kahlerian spacetimes by a generally complex conformal factor. These latter are shown to possess a very rich structure, including the existence of Killing tensors and Killing vectors. A new "explanation" of Newman's complex coordinate transformations is given. It is felt to be superior to previous "explanations" on several counts. For example, a physical interpretation in terms of a symmetry group is given. The existence of new complex coordinate transformations is established: It is shown that any type D vacuum spacetime is obtainable from either Schwarzschild spacetime or "C" spacetime by a complex coordinate transformation. Finally, some related topics are discussed and areas for future work are outlined. (Diss. Abstr. Int., B)

4598 OPTICS OF RELATIVISTIC SOURCES IN A SPHERICALLY SYMMETRIC GRAVITATIONAL FIELD. Campbell, G. A. Austin, TX; Univ. of Texas (1975). 160p. University Microfilms Order No. 75-16,652.

Thesis (Ph. D.).

The effects of spectral shifts and gravitational focussing on radiation from sources moving geodesically in the Schwarzschild gravitational field is analyzed using the general-relativistic equations for geodesic motion and for the propagation of radiation along null geodesics in the geometrical optics approximation. The exact solutions of the Schwarzschild geodesic equations are briefly discussed for the null and time-like cases, and the method of classifying the orbital types of motion based on the effective radial potential is presented. A method of finding the stability of these orbits using this technique is discussed. The geometrical optics approximation for the propagation of radiation is discussed, and the area-intensity law for the Schwarzschild field is derived. The particularly interesting region near R equals 3m is investigated by means of expansions of the exact equations. Numerical techniques for calculating radiation patterns from the propagation equations are discussed, including techniques for obtaining the time variation along geodesics and differences in propagation time along different null geodesics. Finally, the implications of these calculations for the apparent contradiction in energy requirements set by Joseph Weber's observations of galactic gravitational radiation and by astronomical observation are discussed. (Diss. Abstr. Int., B)

4599 GREEN'S FUNCTIONS ON SPHERES AND ON CLOSED ROBERTSON--WALKER SPACETIMES. Hahne, G. E. Austin, TX; Univ. of Texas (1975). 95p. University Microfilms Order No. 75-16,680.

Thesis (Ph. D.).

The objective of this investigation was to carry the theory and calculations of certain Green functions as far as seemed possible toward applications, in particular toward the calculation of the rate of spontaneous creation of scalar particles by strong gravitational fields. The latter calculation has not yet been carried out in full on account of its apparent mathematical intractability. As an introduction to Green functions concern is with the Green function for the Laplacian operator DELTA (or Nabla^2) and the Helmholtz operator DELTA + omega^2 on n-spheres, with a few examples worked out. Subsequently, Green's functions for massless particles on Einstein spacetimes of two (S^1 x T) and four (S^3 x T) dimensions are obtained. By a fortuitous circumstance the conformally invariant equation in the case of the 4-dimensional Einstein space could be worked out in detail. The conformally invariant case predicts no spontaneous creation of particles, however. In the final calculation a special kind of Green function associated with the Klein-Gordon equation was related to the particle creation amplitude for an Einstein universe. (Diss. Abstr. Int., B)

4600 ON THE NEW KINEMATICAL CONSTRAINTS OF THE PAIR OPERATORS IN THE ALGEBRAIC APPROACH TO THE THEORY OF COLLECTIVE MOTION. Yamamura, M. (Kyoto Univ. (Japan). Dept. of Physics). Prog. Theor. Phys. (Kyoto); 52: No. 2, 538-549(Aug 1974).

New kinematical constraints of the pair operators in the algebraic approach to the theory of collective motion are proposed. These relations are the natural extension, to the operator forms, of the well known constraints of the generalized density matrix in the Hartree–Bogoliubov theory. On the basis of the new constraints, a microscopic theory of rotational motion given by Belyaev and Zelevinsky is reconstructed. (auth)

4601 REPORTS ON PROGRESS IN PHYSICS. Volume 37, Part 4, 1974. Ziman, J. M. (ed.). Portland, OR; International Scholarly Book Services, Inc. (1975). 380p. $27.50.

The topics discussed include quantum theory of gravitation, intense ion beams, applications of the Glauber approximation to atomic collisions, the geological time scale, and magnetic impurities in nonmagnetic metals. (JFP)

4602 LINEARIZED MATTER SYMMETRIES AND NON-LINEAR COUNTEREXAMPLES OF EQUIVALENCE TO ISOMETRY IN GENERAL RELATIVITY. Berezdivin, R. (Central Univ. of Venezuela, Caracas). Rev. Mex. Fis.; 23: No. 4, 365-382 (Dec 1974).

The extent to which various symmetries of source terms in general relativity impose isometries is of interest. Several linearized cases of matter symmetries are shown to give rise to isometries. However several types of fluid and null electrovac symmetries in the full theory are shown not to be equivalent to isometries. (auth)

4603 ON THE STABILITY OF RELATIVISTIC SYSTEMS. Friedman, J.L.; Schutz, B.F. (Department of Physics, Yale University, New Haven, Connecticut). Astrophys. J. 200: No. 1, 204-220 (15 Aug 1975).

Using methods applicable to all classical radiative field theories, a necessary and sufficient condition is derived for the onset of instability along a sequence of stationary equilibria in general relativity. A related result is that instability in any mode can set in only when its frequency vanishes. Astrophysical implications are briefly discussed. (auth)

4604 KINKS AND EXTENSIONS. Finkelstein, D.; McCollum, G. (Belfer Graduate School of Science, Yeshiva University, New York, New York 10033). J. Math. Phys. (N.Y.) 16: No. 11, 2250-2259 (Nov 1975).

Kinks, homotopically nontrivial lightcone fields on R^4, can be black holes without curvature singularities, satisfying the weak energy condition. Kinks and all other spherically symmetric stationary spacetimes on R^4 with roots of g_{00} have incomplete geodesics which need extension. For simple roots the Kruskal extension method works and the topology around each root is that of the Kruskal manifold. For multiple roots another extension method is given, based on symmetry, and another topology. (auth)

4605 A NEW SOLUTION OF THE EINSTEIN-MAXWELL EQUATIONS. McLenaghan, R.G.; Tariq, N. (Department of Applied Mathematics, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1). J. Math. Phys. (N.Y.) 16: No. 11, 2306-2312 (Nov 1975).

A space-time is determined which is a solution of the Einstein–Maxwell equations for a nonsingular electromagnetic field and for which the electromagnetic field tensor is weakly parallelly propagated along its principal null directions. A coordinate system is given in which the metric depends upon one essential arbitrary constant.

The space-time admits a four-parameter simply transitive group of motions and its Weyl tensor is of Petrov type I. (auth)

4606 COMMENT ON MALIN'S THEORY OF GRAVITY. Lindblom, L.; Nester, J.M. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). Phys. Rev. D 12: No. 2, 626-627 (15 July 1975).

We find that the theory of gravity proposed by Malin, $R_{\mu\nu}=-4\pi T_{\mu\nu}$, is incompatible with experimental results. (auth)

4607 GRAVITATIONAL THEORIES WITH NONZERO DIVERGENCE OF THE ENERGY-MOMENTUM TENSOR. Smalley, L.L. (Space Sciences Laboratory, NASA/George C. Marshall Space Flight Center, Marshall Space Flight Center, Alabama 35812). Phys. Rev. D 12: No. 2, 376-384 (15 July 1975).

Assuming that the divergence of the energy-momentum tensor is nonzero leads to a class of theories with consistent field equations and gauge conditions as well as compatibility with the Newtonian limit of the conservation laws. We have used both the Einstein and Brans-Dicke theories as models, but the extension to other viable theories such as vector-metric and two-metric theories is possible. One particularly interesting theory emerges that agrees with the ordinary Brans-Dicke theory except for the post-Newtonian parameter ζ_2, which predicts nonconservation of total momentum. Unfortunately no accurate experimental limits for this parameter are known. It thus remains for future experiments in lunar-laser ranging to test this theory. (auth)

4608 TIME-EVOLUTION PROBLEM IN REGGE CALCULUS. Sorkin, R. (California Institute of Technology, Pasadena, California 91109). Phys. Rev. D 12: No. 2, 385-396 (15 July 1975).

The simplectic approximation to Einstein's equations ("Regge calculus") is derived by considering the net to be actually a (singular) Riemannian manifold. Specific nets for open and closed spaces are introduced in terms of which one can formulate the general time-evolution problem, which thereby reduces to the repeated solution of finite sets of coupled nonlinear (algebraic) equations. The initial-value problem is also formulated in simplectic terms. (auth)

4609 GRAVITATIONAL BORN AMPLITUDES AND KINEMATICAL CONSTRAINTS. Grisaru, M.T.; van Nieuwenhuizen, P.; Wu, C.C. (Department of Physics, Brandeis University, Waltham, Massachusetts 02154). Phys. Rev. D 12: No. 2, 397-403 (15 July 1975).

It is shown that in the Born approximation the helicity amplitudes for graviton-graviton scattering are completely determined by kinematical considerations alone, without detailed Feynman graph calculations, reflecting thus the uniqueness of pure Einstein theory. We show that the nonuniqueness of the matter-graviton amplitudes is related to the existence of nonminimal interactions. In the presence of such interactions, helicity is not conserved in elastic scattering of massless particles. A simplified three-graviton vertex with two on-shell gravitons is presented. (auth)

4610 GRAVITATIONAL TWO-BODY PROBLEM WITH ARBITRARY MASSES, SPINS, AND QUADRUPOLE MOMENTS. Barker, B.M.; O'Connell, R.F. (Department of Physics and Astronomy, Louisiana State University, Baton Rouge, Louisiana 70803). Phys. Rev. D 12: No. 2, 329-335 (15 July 1975).

We find the precession of the spin and the precession of the orbit for the two-body problem in general relativity with arbitrary masses, spins, and quadrupole moments. One notable result which emerges is that, in the case of arbitrary masses m_1 and m_2, the spin-orbit contribution to the *spin* precession of body 1 is a factor $(m_2+\mu/3)/(m_1+m_2)$ times what it would be for a test body moving in the field of a fixed central mass (m_1+m_2). Here μ denotes the reduced mass $m_1m_2/(m_1+m_2)$. This contrasts with the result of Robertson for the *periastron* precession where the corresponding factor is unity. These results may be of interest for binary neutron stars and, in particular, for binary pulsars such as PSR 1913+16. (auth)

4611 GRAVITATIONAL WAVE RECEPTION BY A SPHERE. Ashby, N.; Dreitlein, J. (Department of Physics and Astrophysics, University of Colorado, Boulder, Colorado 80302). Phys. Rev. D 12: No. 2, 336-349 (15 July 1975).

The reception of gravitational waves by an elastic self-gravitating spherical detector is studied in detail. The equations of motion of a detector driven by a gravitational wave are presented in the intuitively convenient coordinate system of Fermi. An exact analytic solution is given for the homogeneous isotropic sphere. Nonlinear effects of a massive self-gravitating system are computed for a body of mass equal to that of the earth, and are shown to be numerically important. (auth)

4612 TENTATIVE RELATIVISTIC MODEL FOR NEUTRAL YUKAWA SYSTEMS. Teixeira, A.F.da.F.; Wolk, I.; Som, M.M. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro, Brazil). Phys. Rev. D 12: No. 2, 319-322 (15 July 1975).

Some structurally important results in small as well as in large dimensions are presented concerning a spherical distribution of incoherent dust, the constituents of which are simultaneously sources of gravitational as well as repulsive short-range scalar fields. (auth)

4613 HORIZONTAL PATHS AND THE THOMAS PRECESSION IN THE THEORY OF GRAVITATION. Lapkovskii, A. K. (Mogilev State Pedagogical Inst., USSR); Laptinskii, V. N. Fizika (Zagreb); 18: No. 1, 98-101(1975). (In Russian)

The problem in the theory of gravitation of plotting a family of orthonormal n-hedrons parallel-transferable along local piecewise-differentiable paths is discussed. The relationship to a relativistic effect, known as Thomas precession (or relativity precession), is analyzed with allowance for small-parameter third-order paths. The relations obtained are used to compare qualitatively parallel transfer with the Fermi–Walker transfer. (IAA)

4614 DETERMINATION OF THE SOURCES OF A TETRAD GRAVITATIONAL FIELD. Tuniak, V. N. (Belorussian State Univ., Minsk). Fizika (Zagreb); 18: No. 1, 94-97(1975). (In Russian)

Pellegrini and Plebanski's (1963) formulation of the tetrad theory of gravitation was based directly on Moller's (1961) definition of absolute parallelism in the tetrad formulation of general relativity theory. It is shown that correct definition of the sources of the tetrad gravitational field, in the form of a conical energy-momentum tensor of nongravitational matter in the corresponding absolute-parallelism space, should not contain the addiational terms introduced by Pellegrini and Plebanski. (IAA)

4615 EQUIVALENCE PRINCIPLE IN THE U_4 THEORY OF GRAVITATION. von der Heyde, P. (Univ., Cologne). Lett. Nuovo Cim.; 14: No. 7, 250-252(18 Oct 1975).

The equivalence principle, which links up the special-relativistic description of matter with its general relativistic treatment, is stated in a form which is free from macroscopic definitions and hence immediately applicable to elementary matter fields: locally the properties of special relativistic matter in a noninertial frame of reference cannot be distinguished from the properties of the same matter in a corresponding gravitational field. (JFP)

4616 GRAVITY AND NEUTRINOS–PARADOXES AND POSSIBILITIES. Davis, T. M.; Ray, J.R. (Clemson Univ., SC). Lett. Nuovo Cim.; 14: No. 7, 258-260(18 Oct 1975).

A summary is given of some of the present knowledge of neutrinos interacting with gravitational fields. Some discrepancies and apparently unphysical ghost neutrino solutions are described, and their alternatives discussed. (JFP)

REACTOR TECHNOLOGY AND REGULATION

4617 (NEDC-20989-5) MARK I CONTAINMENT EVALUATION SHORT-TERM PROGRAM: FINAL REPORT. Volume V. Independent Assessment of the Mark I Short-Term Program. (General Electric Co., San Jose, Calif. (USA). BWR Projects Dept.; Teledyne Materials Research Co., Waltham, Mass. (USA)). 26 Sep 1975. vp. (TR-2096(a)). General Electric Co., San Jose, CA.

TMR's conclusions and the reasons for those conclusions are summarized. Since the TMR effort utilized information developed by GE and Bechtel, as opposed to the performance of a complete and parallel evaluation, the present text addresses only the most significant aspects of the problem. It is intended to provide enough description so that this volume can be read without reference to other documentation, including the other volumes of the GE report, but a complete and extensive review of all aspects has not been attempted. (auth)

4618 ON STEEL PRODUCTION BY APPLYING NUCLEAR ENERGY. Shimokawa, K. (Nippon Steel Corp., Tokyo). Denki Kagaku; 42: No. 1, 2-8(Jan 1974). (In Japanese)

Three systems are available in utilizing nuclear energy in the steel producing process. (1) Utilization of electric power based on nuclear power generation. (2) Utilization of nuclear thermal energy as process heat. (3) Combination of the above two. System (1) is the so-called electric pig iron making or electric steel production. System (2) is the method to make reducing gas by using nuclear heat and to reduce iron ore by heating the reducing gas with nuclear heat. The committee for investigating a closed system of steel production has discussed this sytem, and selected a process model to use asphalt as raw material. Trial calculations in West Germany and Japan indicated that nuclear energy application is superior in cost to the blast furnace method for steel production. (JA)

Power Reactors, Non-Breeding, BWR-Type

Refer also to abstracts 4841, 4843, 4853, 4862, 4867, 4871, and 4913.

4619 (BNWL-B-426) ELECTRIC POWER TRANSMISSION FOR A HANFORD NUCLEAR ENERGY CENTER (HNEC). (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Sep 1975. Contract E(45-1)-1830. 64p. Dep. NTIS $5.45.

The major issues examined in the comparison of the DIST and HNEC transmission concepts are: (1) type of transmission to be employed and an assessment of its technical feasibility, (2) availability of rights-of-way, (3) economics, (4) environmental impact, and (5) overall reliability of the transmission system. The type of transmission selected for bulk power transfer from an HNEC for the time period studied is overhead AC, 500 kV double or single circuit, a voltage currently used in the PNW system. This type of system can accommodate growth up to at least 23,000 MW of thermal capacity at an HNEC. Significant additional transmountain capacity needs would require 1100 kV transmission, which should be technologically proved by the end of the 1970s. (auth)

4620 (BNWL-B-458) HANFORD NUCLEAR ENERGY CENTER: AN INTERIM CONCEPTUAL STUDY. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Oct 1975. Contract E(45-1)-1830. 62p. Dep. NTIS $5.45.

A description of the Hanford Nuclear Energy Center (HNEC) concept is presented. The technical and socioeconomic factors supporting the conceptual study are reviewed. 14 references. (DCC)

4621 (NEDO-20533(Suppl.1)) GENERAL ELECTRIC MARK III PRESSURE SUPPRESSION CONTAINMENT SYSTEM ANALYTICAL MODEL. Supplement 1. Bilanin, W. J.; Bodily, R. J.; Cruz, G. A. (General Electric Co., San Jose, Calif. (USA). BWR Projects Dept.). Sep 1975. 45p. General Electric Co., San Jose, CA.

This supplement contains a description of the analytical models used to simulate the associated wetwell pressurization transient resulting from two phase "froth" pool swell flow through restrictions in the containment annulus above the suppression pool, and the long term post-LOCA containment pressure transient caused by core decay heat. The governing equations and assumptions are presented together with comparisons of model predictions with either experimental data or known exact solutions. (auth)

4622 IMPROVEMENTS TO DEVICES FOR ASSEMBLING FUEL ELEMENT BUNDLES FOR A NUCLEAR REACTOR. King, L. D.; Marshall, R. K. (to Exxon Nuclear Co., Richland, Wash. (USA)). French Patent 2,209,172/A/. 28 Sep 1973. 14p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 2 Oct 1972, USA.

The bundle contains, in addition to the fuel elements, several elements forming stay rods. The lower end of the stay rod is screwed into the low mounting plate of the bundle and the upper end is provided with a cam interlock device having an interlock coupling with cams engaged in the seat of an opening of the upper mounting plate of the bundle. There is a right control coupling engaged in an opening of the mounting plate. A method is provided to pass the cams into the seats of the mounting plate after rotation by the inclined surfaces. There are also a screw and an inset coupling. The fuel element bundle is particularly suitable for a boiling water reactor. (tr-FR)

4623 A DEVICE FOR SUPPORTING A NUCLEAR REACTOR CORE. Costes, Didier. (to CEA, 75-Paris (France)). French Patent 2,214,938/A/. 23 Jan 1973. 11p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

Description is given of a device for supporting the core of a nuclear reactor by anchoring in the concrete vessel. That device is constituted by a cylindrical sleeve surrounding the vessel, said sleeve being made integral with a plurality of frusto-conical skirts with intersecting axes substantially perpendicular to the axis of the vessel. The minor base of the skirt is integral with said sleeve whereas its major base is anchored in orifices of the reactor vessel through which pass fluid conduits, said sleeve being integral at the upper portion thereof with the reactor vessel upper portion and comprising a flat portion at each of its connections with the frusto-conical skirts. That device can be applied to boiling water reactors. (FR)

4624 OPERATING EXPERIENCE OF THE US LIGHT WATER REACTORS. Richardson, J. A. Nucl. Eng. Int.; 20: No. 230, 463-466(May 1975).

A report on operating experiences of American light water reactors has been compiled with selected extracts from representative official AEC reports. In addition, references are made to specific and generic plant design problem topics. Concluding comments are addressed to future nuclear industry trends. (auth)

4625 BROWNS FERRY FIRE. Rippon, S. Nucl. Eng. Int.; 20: No. 230, 461-462(May 1975).

Some of the lessons to be learned from the fire at Browns Ferry are discussed. The cause of the fire, which started in the cable spreading room, and the sequence of events which followed are described. The status of the various safety systems and instrumentation on each reactor, during the incident, are surveyed. (UK)

4626 DEVICE FOR REFUELING A NUCLEAR REACTOR HAVING A CORE COMPRISING A PLURALITY OF FUEL ASSEMBLIES. Van Santen, A.; Elofsson, K. (to Allmanna Svenska Elektriska Aktiebolaget). US Patent 3,904,048. 9 Sep 1975. Priority date 2 Dec 1968, Sweden. 18p.

A nuclear reactor formed of fuel assemblies each including a plurality of parallel fuel rods arranged in a predetermined fuel rod lattice, which rods are freely extractable and insertable at one end of the fuel assembly, is refueled by extracting from one of the fuel assemblies a number of fuel rods substantially less than the total number of fuel rods and replacing these by inserting new fuel rods into the vacated positions. The removal and return of the rods is produced by a tool having a plurality of gripping members capable of engaging shoulders beneath heads formed on the upper ends of the fuel rods. This may be accomplished by providing a tool having a number of gripping members attached to the tool body corresponding to the lattice positions of the fuel rods to be extracted, having gripping members which can be pushed together to grip beneath shoulders on the upper ends of the fuel rods. (Official Gazette)

4627 CONTAINMENT VESSEL CONSTRUCTION FOR NUCLEAR POWER REACTORS. Sulzer, H. D.; Coletti, J. L. (to Stone and Webster Engineering Corp.). US Patent 3,899,391. 12 Aug 1975. Filed date 12 Jun 1973. 6p.

A nuclear containment vessel houses an inner reactor housing structure whose outer wall is closely spaced from the inner wall of the containment vessel. The inner reactor housing structure is

divided by an intermediate floor providing an upper chamber for housing the reactor and associated steam generators and a lower chamber directly therebeneath containing a pressure suppression pool. Communication between the upper chamber and the pressure suppression pool is established by conduits extending through the intermediate floor which terminate beneath the level of the pressure suppression pool and by inlet openings in the reactor housing wall beneath the level of the pressure suppression pool which communicate with the annulus formed between the outer wall of the reactor housing structure and the inner wall of the containment vessel. (Official Gazette)

4628 NUCLEAR FUEL ELEMENT CONTAINING PARTICLES OF AN ALLOYED Zr, Ti, AND Ni GETTER MATERIAL. Grossman, L. N.; Levin, H. A. (to General Electric Co.). US Patent 3,899,392. 12 Aug 1975. Filed date 8 Dec 1971. 8p.

A nuclear fuel element for use in the core of a nuclear reactor is disclosed. The nuclear fuel element has disposed therein an alloy having the essential components of nickel, titanium and zirconium, and the alloy reacts with water, water vapor and reactive gases at reactor ambient temperatures. The alloy is disposed in the plenum of the fuel element in the form of particles in a hollow gas permeable container having a multiplicity of openings of size smaller than the size of the particles. The openings permit gases and liquids entering the plenum to contact the particles of alloy. The container is preferably held in the spring in the plenum of the fuel element. (Official Gazette)

4629 OPERATIONAL EXPERIENCE WITH HEAT EXCHANGERS IN NUCLEAR POWER STATIONS WITH LIGHT WATER REACTORS. Baschek, H.; Kocourek, E. Combustion; 47: No. 3, 14-23(Sep 1975).

The design and operation of BWR and PWR steam generators and heat exchangers are discussed. Extensive operational data are presented for steam generators which have been in extended service at BWR and PWR plants. (DG)

4630 OUTLINE OF NUCLEAR POWER PLANT WITH BOILING WATER REACTOR. Nishizawa, H.; Hayashi, Y. (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Haikan Gijutsu; 16: No. 6, 116-130(May 1974). (In Japanese)

The main pipings around nuclear reactors are those for control rod driving, coolant recirculation, steam transportation, feedwater transportation and supplementary systems. The most peculiar system is an emergency core cooling system. This system can operate in case of accidents such as the rupture of primary coolant piping. This system comprises a high pressure injection system, a low pressure injection system, a core spray system and an automatic depressurization system. They can automatically start without any external electric power. In Japan, the number of the nuclear power plants with boiling water reactors in operation is two. One station is in the final adjusting stage, and 8 stations are under construction. (JA)

4631 EFFECT OF DISSOLVED OXYGEN ON DEPRESSION OF THE CRUD FORMATION IN FEED WATER SYSTEM OF BWR. Mizuno, T.; Iwahori, T. (Central Research Inst. of Electric Power Industry, Komae, Tokyo (Japan). Technical Lab. No. 1). Denryoku Chuo Kenkyusho Gijutsu Daiichi Kenkyusho Hokoku; No. 74011, 1-4, 1-18(Jul 1974). (In Japanese).

The effect of dissolved oxygen on depression of crud formation was surveyed and discussed, and its application to a power plant was proposed. It was concluded that: (1) When the concentration of dissolved oxygen exceeds about 100 ppb, its effectiveness is remarkable. (2) On the chemical equilibrium, dissolved oxygen is available to passivate iron in pure water. (3) From the discussion of kinetics, it is suggested that iron-oxide or -hydrate is formed in the laminar sublayer, when the concentration of dissolved oxygen is 100 ppb. (4) It may be that pitting and cracking of mild steel and stainless steel do not occur, when the concentration of dissolved oxygen is about 100 ppb. (5) In applying it to a power plant, some problems remained unsolved. (auth)

4632 BUSHING FOR A HIGH-TEMPERATURE AND HIGH-PRESSURE VESSEL. Ito, T. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1974-9836/B/. 4 Oct 1968. 3p. (In Japanese)

A bushing is described for extracting an electric signal wire from high-pressure, high-temperature containers as found in reactors such as the BWR type. A metal receptacle having a longitudinal aperture is fixed to the container wall such that the aperture communicates with the interior of the container through a hole provided therin and said receptacle is threaded to receive a screw member having a longitudinal aperture through which a narrow metal tube penetrates into the container. A signal wire is extracted through the narrow metal tube and sealed at the outer end by soldering. A water seal between the outer surface of the metal tube and the inner surface of the screw member aperture is accomplished by an insulating packing. (JA)

4633 TEST RIG FOR INVESTIGATION OF CORROSION CRACKING OF STAINLESS STEELS IN A FLOW OF WATER OF HIGH PARAMETERS IN THE PRESENCE OF HEAT TRANSFER. Gashenko, V. A.; Bogoyavlenskii, V. L.; Nesmeyanova, K. A.; Aleksandrova, N. M.; Kasatkin, V. I.; Larionov, N. P.; Shevtsov, A. P. Therm. Eng. (USSR). (Engl. Transl.); 21: No. 10, 66-69 (1974).

Translated from Teploenergetika; 21: No. 10, 49-51(1974).

A description is presented of an experimental test rig constructed to study the behavior of steels under conditions of indirect stress due to elevated expansion stresses and high heat fluxes. The test rig makes it possible to conduct experiments over a wide range of variation in quality of water and heat loads. (auth)

Power Reactors, Non-Breeding, PWR-Type

Refer also to abstracts 4619, 4620, 4624, 4627–4629, 4633, 4830–4833, 4841, 4843, 4849–4851, 4853–4855, 4862, 4871, 4911, 4921–4925, and 4932.

4634 (CENPD-67(Rev.1)(Add.2)) IODINE DECONTAMINATION FACTORS DURING PWR STEAM GENERATION AND STEAM VENTING. Topical Report. (Combustion Engineering, Inc., Windsor, Conn. (USA)). Aug 1975. 20p. Combustion Engineering, Inc., Windsor, CT.

This addendum submits responses to the NRC request for additional information on the Topical Report CENPD-67, Revision 1, entitled "Iodine Decontamination Factors During PWR Steam Generation and Steam Venting." Each request for information is provided with its appropriate response following. (auth)

4635 (CONF-740370-, pp 425-434) OFF-GAS TREATMENT FOR PRESSURIZED WATER REACTORS BY ABSORPTION OF XENON AND KRYPTON IN FLUOROCARBONS. Griffith, G. A.; Baldwin, T. L. (Nuclear Power Generation Div., Lynchburg, VA). 1974.

From fourth annual industrial air pollution control conference; Knoxville, Tennessee, USA (28 Mar 1974).

In proceedings of the fourth annual industrial air pollution control conference. (Tennessee Univ., Knoxville (USA). Dept. of Civil Engineering).

Pilot plant tests showed selective absorption of krypton and xenon in dichlorodifluoromethane produced concentrations as low as 40 ppb and 3 ppb, respectively. Satisfactory operation was demonstrated for a variety of carrier gases including hydrogen, nitrogen, air, helium, and argon. Charcoal absorption, cryogenic absorption, and cryogenic distillation techniques were compared disadvantageously to the fluorocarbon solvent method. (PCS)

4636 (CONF-750607-36) TEMPERATURE MEASUREMENT ON ZIRCALOY-CLAD FUEL PINS DURING HIGH-TEMPERATURE EXCURSIONS. Meservey, R. H. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). 1975. 2p. Dep. NTIS $4.50.

From American Nuclear Society meeting; New Orleans, Louisiana, USA (8 Jun 1975).

Special thermocouples and attachment techniques developed for use in measuring surface temperatures of Zircaloy-clad PWR reactor fuel pins during high temperature excursions are described. (auth)

4637 (WCAP-7958-A) DNB TEST RESULTS FOR NEW MIXING VANE GRIDS. Cadek, F. F.; Motley, F. E. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Nuclear Energy Systems Div.). Jan 1975. 58p. PWR Systems Div., Pittsburgh.

As part of the continuing experimental program to investigate Departure from Nucleate Boiling (DNB) in rod bundles a series of tests using a new mixing vane grid design have been performed. This new grid has a reinforced type structure and is designated the "R" grid. Effects on DNB due to non-uniform axial heat flux distribution, heater rod length, and axial grid spacing were investigated. The test configuration simulated reactor "typical" coolant channels, i.e., surrounded by heated rods. With the results of this series of DNB tests (197 data points) a modified spacer factor was developed for application to the new R grid fuel rod bundles. This spacer factor is applied as a multiplet on the W-3 prediction of DNB heat flux. Use of this spacer factor as a multiplier on the W-3 correlation results in conservative prediction of DNB heat flux compared to the data. (auth)

4638 (WCAP-7958(Add.1-A)) DNB TEST RESULTS FOR R GRID THIMBLE COLD WALL CELLS. Cadek, F. F.; Motley,

F. E. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). Jan 1975. 32p. Westinghouse Electric Corp., Pittsburgh.

Two sets of type "R" mixing vane grid DNB data from a 4 x 4 rod bundle, where one of the central rods is a simulated control rod thimble, are presented. The range of parameters for this thimble cold wall data is given. The results show that the W-3 correlation with cold wall factor and the Modified Spacer Factor is applicable to "R" grid thimble cold wall rod bundle data. (7 references) (auth)

4639 (WCAP-8599) AXIAL POWER DISTRIBUTION MONITORING SYSTEM. Jones, K. A.; Kerr, R. A.; Calpin, J. E. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Nuclear Energy Systems Div.). Aug 1975. 88p. Westinghouse Electric Co., Pittsburgh, PA.

The Axial Power Distribution Monitoring System (APDMS) is a surveillance tool that utilizes the standard incore movable detectors to verify compliance with technical specification limits on the linear heat rate hot channel factor, F/sub Q/. Topics covered in this report are: system functions and mechanical operations, system calibration including operational and alarm setpoints and an error analysis concerning the uncertainties of APDMS determinations of F/sub Q/. Specific details of electronic design are not included. The results of operational experience at the H. B. Robinson and Zion nuclear power stations are also presented. (auth)

4640 FIXED RADIOPROTECTION MEASUREMENTS IN PRESSURIZED WATER STATIONS. Gaulard, R. (Electricite de France, 75-Paris). pp 247-257 of 8th National Congress on the Control of Ionizing Radiations. Chatenay-Malabry, France: Association des Techniciens Superieurs en Radioprotection ([nd]). (In French).

From 8th congress of the Health Physicist's Association; Chatenay-Malabry, France (5 Jun 1973). Distributed by Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry (France).

The role of fixed radioprotection measurements is recalled and these measurements are listed. They fall into three groups: activity of liquids, activity of gases and gamma radiation level in the premises of the supervised zone. For each of these measurements the technical specifications, conditions of use and alarm systems employed are defined. (FR)

4641 SYSTEM FOR THE SUPERVISION OF METALLIC IMPACTS SUFFERED BY AN EQUIPMENT. Gopal, Raj; Carteus, M. F. M. (to Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). French Patent 2,215,624/A/. 28 Jan 1974. 14p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 29 Jan 1973, USA.

An impact monitoring system for metallic body impacts is described. It contains at least one collector-transducer transmitting an electrical system representative of the energy of each impact sustained by an associated component at the resonance frequency of this component. There is a first and a second circuit connected in parallel with the output of the collector, preferably after filtration of the background. The two circuits give respectively a first signal representative of the cadence of impacts and a second signal representative of the energy level of each impact. This system is especially useful in the early detection of the impact of metallic debris in suspension in the coolant of a reactor. (tr-FR)

4642 LAST DEVELOPMENTS OF NUCLEAR FUEL FOR PWR REACTORS. Leclercq, J. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92-Courbevoie (France)); Nakazato, S. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). PWR Systems Div.). pp 23-26 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 Apr 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975).

Pressurized water reactor fuel element design has been rapidly evolved since the beginning of its commercialization. This evolution was first directed by the objectives of improving the economics and led to the 15 × 15 fuel assembly design. During the same period, the safety commissions and particularly the USAEC worked out very restraining safety criteria, which led to a reduction of the fuel linear power and the conception of the 17 × 17 fuel assembly. Many mechanical and thermohydraulic tests were performed to justify this design. (FR)

4643 VIBRATION BEHAVIOR OF PWR REACTOR INTERNALS. Assedo, R.; Dubourg, M. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92-Courbevoie (France)); Livolant, M. (CEA Centre d'Etudes Nucleaires de Saclay, 91-Gif-sur-Yvette (France). Service des Etudes Mecaniques et Thermiques). pp 32 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 Apr 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975).

The program for studying the vibration behavior of PWR reactor internals is presented. Theoretical work and experimental studies on reduced and full scale models were carried out. The hydrodynamic effects of random excitations and acoustic noises were studied. (FR)

4644 QUALITY ANALYSIS IN PRESSURIZED WATER REACTOR FUEL. Darolles, J. F. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92-Courbevoie (France)). pp 203-205 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 Apr 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975).

An integrated system which has been set up to administrate and analyze the quality is described. This system is in actual operation. The basic principles for the quality analysis system are traceability, i.e., identification, location and history of fuel components and quality evaluation during manufacturing. The quality analysis system operates in the following areas: data recording and transmission, data processing, quality file generation. The interest of such a system may be noted particularly in manufacturing, for the constitution of quality files, the design of products and the processing of data from irradiated fuel assemblies. (FR)

4645 VIBRATIONS MEASUREMENT IN FAST AND PWR REACTOR STUDY. Tigeot, Y.; Epstein, A.; Hareux, F. (CEA Centre d'Etudes Nucleaires de Saclay, 91-Gif-sur-Yvette (France). Service des Etudes Mecaniques et Thermiques). Bull. Inf. Sci. Tech. (Paris); No. 201, 33-45(Mar 1975). (In French).

In the past, severe damage has occured in several nuclear reactors by structural vibrations induced by the primary coolant flow. To avoid this kind of trouble, the SEMT studies two different types of reactor. For the pressurized water reactors, some tests have been made on the SAFRAN test loop, which is a three loop 1/7 scale internal model of a 900 MW(e) reactor. Elsewhere, measurements have been made on the Phenix reactor, and studies are planned for the Super Phenix reactor. (FR)

4646 THE UTILITY OWNER EXPERIENCE IN THE FUEL MANAGEMENT OF THE SENA REACTOR. Charransol, P. (Electricite de France, 92-Courbevoie. Service Etudes et Projets Thermiques et Nucleaires). pp 135-136 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975). (American Nuclear Society, Hinsdale, Ill.).

The calculation method developed to solve fuel management problems of the SENA reactor is presented. Comparison between measurements and predictions shows that the computation method used for the reactor loaded with UO_2 assemblies gives: cycle length with an associated uncertainty of 3%, power distribution with an associated uncertainty of 2 to 5%, and isotopic fuel composition with an uncertainty of 2 to 4%.

4647 STEAM GENERATOR. Mayer, H.; Schroeder, H. J. (to Siemens Aktiengesellschaft). US Patent 3,898,961. 12 Aug 1975. Priority date 26 Jun 1972, F. R. Germany. 4p.

A pressurized-water coolant nuclear reactor steam generator has a vertical housing for the steam generating water and contains an upstanding heat exchanger to which the pressurized-water coolant passes and which is radially surrounded by a guide jacket supporting a water separator on its top. By thermosiphon action the steam generating water flows upward through and around the heat exchanger within the guide chamber to the latter's top from which it flows radially outwardly and downwardly through a down draft space formed between the outside of the jacket and the housing. (Official Gazette)

4648 NUCLEAR REACTOR ASSEMBLY. Dorner, H.; Scholz, M.; Jungmann, A. (to Siemens Aktiengesellschaft). US Patent 3,899,393. 12 Aug 1975. Priority date 31 May 1972, F. R. Germany. 4p.

A nuclear reactor assembly includes a reactor pressure tank

having a substantially cylindrical side wall surrounded by the wall of a cylindrical cavity formed by a biological shield. A rotative cylindrical wall is interposed between the walls and has means for rotating it from outside of the shield, and a probe is carried by the rotative wall for monitoring the pressure tank's wall. The probe is vertically movable relative to the rotative cylindrical wall, so that by the probe's vertical movement and rotation of the rotative cylinder, the reactor's wall can be very extensively monitored. If the reactor pressure tank's wall fails, it is contained by the rotative wall which is backed-up by the shield cavity wall. (Official Gazette)

4649 ELECTRICAL AUXILIARIES FOR KEPCO'S TAKAHAMA POWER PLANT. Inoue, T.; Tsuda, M.; Yamada, S.; Matsumoto, N. (Mitsubishi Electric Corp., Tokyo (Japan)). Mitsubishi Denki Giho; 48: No. 11, 1268-1273(Nov 1974). (In Japanese)

Kansai Electric Power's Takahama facility is a nuclear power plant having two pressurized-water reactors, with electrical outputs of 826 MW each. Construction of the No. 1 unit was started in December 1969, and it was put into initial power for trial in March 1974, generating the largest unit output of any existing nuclear power plant in Japan. The No. 2 unit is currently in trial operation. The electrical auxiliary equipment, standards and policy for the safety of nuclear reactors, and some examples of problems encountered in the design of the electrical auxiliaries are discussed. (auth)

4650 THREE-PHASE 860 MVA 275 kV POWER TRANSFORMERS FOR KEPCO'S TAKAHAMA POWER PLANT. Tajima, T.; Ono, T. (Mitsubishi Electric Corp., Amagasaki, Hyogo (Japan). Itami Works). Mitsubishi Denki Giho; 48: No. 11, 1287-1291 (Nov 1974). (In Japanese)

In two three-phase 860MVA 275kV transformers supplied from Mitsubishi Electric in 1973 achieved a new high in terms of capacity. Shell-form form-fit construction is employed, with two sets of series coils, each equivalent to 430MVA, mounted on the same core leg and connected in parallel. By this means the increase in core size (due to increased capacity) and leakage flux and stray loss (proportional to ampere turns) were held to the minimum. Due to their unprecedented shipping weight of 411 tons each, they were transported to the power plant by sea. Technical problems encountered in the manufacture of the 1000MVA-class transformers soon to be used in fossil-fuel and nuclear power plants are discussed, and the development and test programs now in progress are outlined. (auth)

4651 SILICONE-RUBBER-INSULATED CABLES FOR CALVERT CLIFFS NUCLEAR POWER PLANT. Bhatia, P. (Baltimore Gas and Electric Co.). Nucl. Saf.; 16: No. 6, 714-719(1975).

Early in 1970 the Baltimore Gas and Electric Company decided to use silicone-rubber-insulated cables, size No. 2 AWG and smaller, for all low-voltage power, control, and instrumentation applications for the Calvert Cliffs Nuclear Power Plant, Units 1 and 2. The decision was based on extensive tests made by the company to determine the optimum balance of properties of control and power cables to ensure their satisfactory operation during a severe fire and after exposure to radiation. Results of the tests indicated that silicone-rubber-insulated cables (methyl–phenyl–vinyl-base compound) with glass braid over the insulated conductors, asbestos fillers, and overall asbestos-braid jackets will operate successfully during and after an oil fire and after exposure to a total radiation of 10^8 rads and borated steam. (auth)

4652 STUDY ON THE APPLICATION OF OPTIMUM LOAD SHEDDING. Song, K. Y.; Lee, K. J. J. Korean Inst. Electron. Eng.; 24: No. 2, 180-187(1975). (In Korean)

The results are described of a study of the system characteristics, especially for the abnormal frequency drop of power system, when a large generating unit such as Kori Nuclear 1 (595MW) pulls out from the system. The automatic load shedding method now adopted in the system was re-studied to ameliorate the above problem. From the results of the study, a new under-frequency relay with an element for detecting the slope of frequency change and with time delay element to raise the lowered frequency to a desired value, was found to be effective, and should be purchased and utilized. An optimal and concrete load shedding method was recommended for reliable operation of power system. (Korean Sci. Abstr.)

4653 STUDY ON THE CHARACTERISTIC OF SYSTEM FLUCTUATION UNDER LARGE GENERATOR UNIT OUTAGE. Song, K. Y.; Rieh, C. H.; Kim, Y. C. J. Korean Inst. Electron. Eng.; 24: No. 2, 167-173(1975). (In Korean)

The results are described of a study of the stability of power system when the Kori-1 reactor is operated with existing system. First, a transient disturbance, which affects the stability of entire power system, was analyzed, and to cope with the problem a load shedding method was studied to recover the fluctuation of the power system. Second, transient stability problem was studied when three phase fault occurs in the 345 Extra High Voltage Power System, and from this result, it was found to be highly effective that high speed protecting device should be provided and operated to recover the fault. (Korean Sci. Abstr.)

Power Reactors, Non-Breeding, Graphite Moderated

Refer also to abstracts 4676 and 4839.

4654 (GA-A-13506) HTGR FUEL PERFORMANCE. Harmon, D. P.; Dahlberg, R. C.; Schleifer, P.; Finkbeiner, R. (General Atomic Co., San Diego, Calif. (USA)). 1 Oct 1975. Contract E(04-3)-167. 16p. (CONF-751030-1). Dep. NTIS $4.00.

From international nuclear industries fair; Basel, Switzerland (7 Oct 1975).

The reference fuel for the thorium cycle HTGR is composed of BISO-coated fertile particles and TRISO-coated fissile particles. These particles are blended together and bonded into fuel rods with a carbonaceous matrix. The fuel rods are then inserted into graphite fuel blocks. Results of irradiation test programs are presented. (auth)

4655 (NP-20735) GENERAL ATOMIC QUALITY ASSURANCE PROGRAMS. Draft of Amendment 2 to LTR-11. (General Atomic Co., San Diego, Calif. (USA)). 18 Aug 1975. 62p. General Atomic Co., San Diego, CA.

This report establishes the General Atomic HTGR Plant Quality Assurance Program from which the General Atomic Quality Assurance Manual will be prepared and implemented, and provides the basis of the Quality Assurance Program implemented at General Atomic Company during the design, procurement, manufacturing, construction, and testing phases of an HTGR nuclear steam supply system. (auth)

4656 (RD/B/N-3269) CALIBRATION OF A CYLINDRICAL PRESSURE PROBE FOR RECIRCULATING FLOW MEASUREMENTS. Lawn, C. J. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Jun 1975. 31p. Dep. NTIS (US Sales Only) $5.00.

The use of the pressure distribution around a cylinder in cross-flow to indicate the magnitude and direction of the velocity vector is discussed in the context of making measurements in highly turbulent recirculating flows. The intended application is the measurement of the flow between the ribs on a large-scale model of the AGR fuel pin surface. Results from a number of calibration experiments in boundary layers are used to provide a correlation for the positions at which local static pressure is measured on the cylinder surface. After appropriate corrections, the dynamic pressure is deduced from the pressure at the stagnation point. Corrections are also necessary in deducing the direction of flow from the bisector of the static pressure positions, when the cylinder is in a shear flow or near a wall, and these too are evaluated from the results of the calibration experiments. Measurements in two recirculating flows are then presented as an illustration both of the validity and limitations of the technique. (auth)

4657 20 YEARS EXPERIENCE IN METALLIC NATURAL URANIUM FUEL CYCLE. Boudouresques, B. (CEA Centre d'Etudes Nucleaires de Saclay, 91–Gif-sur-Yvette (France). Div. d'Etude et de Developpement des Reacteurs); Le Diguou, A. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Service de Fabrication Industrielle des Elements Combustibles et Materiaux de Structure); Le Noc, J. P. (CEA Direction des Productions, 92–Chatillon (France). Sous-Direction du Plutonium); Couture, P. (Electricite de France, 75–Paris. Service de la Production Thermique). pp 105-108 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975).

Fuel development and performances of the French natural uranium-graphite-gas series (GCR) are presented. From the solid rods of G2 and G3 to the hollow, closed rod of UMo 1.1% alloy of CH2 and CH3, the CEA developed a graphite core element that was to be used in all the other reactors except Bugey 1. In

the case of Bugey 1, an annular form for the uranium tube, with internal and external cooling was adopted. (FR)

4658 HIGH TEMPERATURE REACTOR STEAM GENERATOR DESIGN AND SYSTEM IMPLICATIONS. Bachmann, U. (Sulzer Bros. Ltd., Winterthur (Switzerland)). pp 50 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference: Paris, France (21 Apr 1975). (American Nuclear Society, Hinsdale, Ill.).

The heat exchanger of the 300MW(e) THTR reactor for the Schmehausen plant is described. Its performance and operation are studied. (FR)

4659 THE RADIOLYTIC CORROSION OF GRAPHITE IN THE BUGEY REACTOR. Blanchard, R.; Koch, C. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Metallurgie); Laurent, J. M. (Electricite de France, 01-Loyettes. Centrale de Bugey). pp 75-77 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975). (American Nuclear Society, Hinsdale, Ill.).

Three techniques were used: weight loss measurements on small specimens of graphite placed in the interior of fuel element graphite sleeves; analysis of reactor gas composition; and tracer analysis of graphite samples labeled with ^{14}C. (FR)

4660 PROCESS FOR MAKING A FUEL ELEMENT FOR HIGH TEMPERATURE NUCLEAR REACTORS. Bujas, R.; Ringot, C. (to Commissariat a l'Energie Atomique). US Patent 3,900,358. 19 Aug 1975. Priority date 8 Jan 1971, France. 4p.

The fuel element comprises a central fuel portion or compact of generally annular shape formed by a stack of annular segments and surrounded externally and internally by a jacket. The jacket is formed by at least one sheet of felt or fabric of carbon or graphite, the sheet being bonded to the fuel portion by means of pyrocarbon obtained by pyrolysis of hydrocarbons in gaseous phase. The fuel element is mainly intended for use in high-temperature reactors. (Official Gazette)

Power Reactors, Non-Breeding, Otherwise Moderated

Refer also to abstracts 3641 and 4863-4866.

4661 (AECL-5107) ROLE OF ZIRCONIUM ALLOY METALLURGY IN THE FABRICATION OF CANDU FUEL. Holt, R. A.; Evans, W.; Cheadle, B. A. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Jun 1975. 17p. (CONF-750677-1). Dep. NTIS (US Sales Only) $4.00.

From 4th inter-American conference on materials technology; Caracas, Venezuela (29 Jun 1975).

The emphasis on neutron economy in their design allows CANDU reactors to utilize uranium resources more efficiently than any other commercial reactor. The use of zirconium alloys is an essential feature of the neutron-economic design, and CANDU fuel is clad with thin-walled Zircaloy fuel sheathing. A sound basic understanding of the physical metallurgy of zirconium alloys is required to specify fuel sheath properties and fabrication processes which ensure economic fuel performance. Most commercial fabrication processes for Zircaloy sheathing yield the desirable fine α-grain structure that provides good ductility. However, close control of the final cold-reduction and annealing treatments is essential to optimize the mechanical properties. Due to the hexagonal close packed crystal structure of α-zirconium, pronounced crystallographic textures are produced during the forming operations and thus the properties are anisotropic. The mechanical anisotropy of the sheathing can be optimized by controlling the ratio of reduction in diameter to reduction in wall thickness in the final stages of fabrication. This allows the fuel manufacturer to order sheathing with prescribed longitudinal and circumferential properties. High-speed inert-atmosphere welding and brazing processes are used in assembling the fuel to minimize detrimental effects including oxygen pickup and grain growth. In addition, the concentration of carbon in the fuel sheathing is specified to exceed a minimum value to ensure the presence of ZrC second-phase particles which refine the α-grain size in weld and braze heat-affected-zones. This understanding of the physical metallurgy of the fabrication processes has contributed to the fabrication of fuel of consistent high quality. (auth)

4662 (JUL-1225) METHOD OF INTERVAL-DISTRIBUTION MEASUREMENT FOR REACTIVITY DETERMINATION IN NUCLEAR REACTORS. Grenz, G. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Reaktorentwicklung). Jul 1975. 117p. (In German). Dep. NTIS (US Sales Only) $6.50.

Interval-distribution measurement is a statistical analysis of the time intervals between consecutive counts of a neutron detector for the determination of reactivity and power of a multiplying system. The procedure, which represents an advantageous alternative to ROSSI-α-, FEYNMAN-α-, and P_o- experiments, is methodically analysed. At first the theory of branching processes is developed for monoenergetic neutrons in a point-reactor model. By numerical variation of relevant parameters such as neutron source strength, detector sensitivity, or reactivity, the favored range for interval-distribution measurements has been evaluated. An experimental setup and a computer program for data analysis were developed and experiments carried out at the SUR and ITR reactors. The constraints for successful measurements are given. Interval-distribution measurements are possible with errors less than 5% for reactivities below -0.2 $ and neutron source strengths $s < 4/A$. (auth)

4663 A PRESSURE TUBE REACTOR. Takada, Y. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1974-8677/B/. 25 Nov 1968. 2p. (In Japanese)

An upper shielding plate of a calandria tank is heated by gamma rays from the core of a pressure tube reactor since it possesses a thickness of about 50 mm. A heat conducting grid of lattice form is secured to the inner wall of the upper shielding plate while the grid is partially dipped in heavy water in the reactor. Since the heat is transmitted from the upper shielding plate to the heavy water, the shielding plate is effectively cooled by the heat conducting grid. (JA)

4664 PRESSURE TUBE TYPE REACTOR. Azuma, M. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1974-23516/B/. 25 Nov 1968. 3p. (In Japanese)

In a pressure tube type reactor, pressure tubes are arrayed into the form of a lattice in a calandria tank containing heavy water, a shielding layer is provided over an upper plate of the calandria tank, and a thermally insulating gas is caused to flow through the interspace between the calandria tank and the shielding layer. During the reactor operation, heat is generated in the shielding layer due to gamma ray irradiation. When the flow rate of the gas is increased in order to cool the shielding layer, the heat insulating effect originally intended is lowered and thermal stresses arise in the upper plate of the calandria tank with the result that the tank is degraded. According to this invention, the upper surface of the calandria tank is immersed in the heavy water within the reactor, and a shielding portion protruding onto the heavy water side is provided, whereby the heat generated in the shielding layer is absorbed. Further, beneath the upper surface of the calandria tank as immersed in the heavy water, there are disposed heavy water collecting means which gather the heavy water used for cooling the calandria tank and promptly send it out of the reactor so as to eliminate the heat. (auth)

4665 PRESSURE TUBE TYPE REACTOR. Higashi, M.; Takada, Y. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1974-22279/B/. 27 Dec 1968. 2p. (In Japanese)

In a pressure tube type reactor, heavy water is received in a calandria tank, and a buffer gas is contained above the heavy water. The surface of the heavy water fluctuates due to a variation in the flow rate of the buffer gas, the circulation of the heavy water in the calandria tank, or the insertion of a control rod. This invention absorbs the fluctuation of the heavy water surface above the reactor core. To this end, the upper surface of the calandria tank is held in contact with the heavy water, or an upper plate of the calandria tank is provided with a vibration absorber which is held in contact with the heavy water. (JA)

Power Reactors, Breeding

Refer also to abstracts 3641, 4645, 4834-4836, 4843, 4846, 4857, 4869, 4870, and 4912.

4666 (AERE-TP-606) THEORY OF MASS TRANSPORT IN LIQUID CIRCUITS. Clement, C. F. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). 1975. 43p. Dep. NTIS (US Sales Only) $5.00.

The isothermal solubility experiments which could be used to obtain the surface reaction rate and diffusivity parameters are described. Molecular mass transport in loops is then treated with a collection of mass transfer coefficients to be used when diffusivities are small. Types of circuit behavior described include the approach to saturation in isothermal legs, the characteristics of rising tem-

perature regions and the dependence on geometrical properties in simple circuits. A surface temperature effect is shown to produce a possible corrosion peak at the entrance to an isothermal hot leg. A coupled model for the transport of small particles and molecular species is formulated in which particle growth and dissolution is allowed, and the expected size of persistent particles in circuits is discussed. Some problems associated with extension of the theory to multicomponent systems are briefly described. (auth)

4667 (ANL-75-21) TWO-DIMENSIONAL FLUID-HAMMER ANALYSIS BY THE METHOD OF NEARCHARACTERISTICS. Shin, Y. W.; Kot, C. A. (Argonne National Lab., Ill. (USA)). May 1975. Contract W-31-109-eng-38. 27p. Dep. NTIS $4.00.

A numerical technique based on the method of nearcharacteristics is considered for solving propagation of fluid-hammer waves in a two-dimensional geometry. The solution is constructed by relating flow conditions by compatibility equations along lines called nearcharacteristics. Three choices are considered in the numerical scheme that are accurate within an error of the order of magnitude of the time step. Since the nearcharacteristics lie in the coordinate planes, the technique provides an efficient method requiring only simple interpolations in the initial plane. On the other hand, the nearcharacteristics fall outside the characteristics cone. Thus the solution procedure directly refers to conditions outside the true domain of dependence. The effect of this is studied through numerical calculation of a simple example problem and comparison with results obtained by a bicharacteristic method. Comparison is also made with existing analytical solutions and experiments. Furthermore, the three solution schemes considered are examined for numerical stability by the vonNeumann test. Two of the schemes were found to be unstable; the third yielded a stability criterion equivalent to that of the bicharacteristic formulation. The stability-analysis results were confirmed by numerical experimentation. (auth)

4668 (ANL-Trans-992) PHENIX REACTOR CIVIL ENGINEERING TECHNICAL PROBLEMS AND SOLUTIONS. Labat, P.; Lacroix, R.; Magnas, J. P. Translated from Ann. Inst. Tech. Batim. Trav. Publics; No. 304, 121-147(Apr 1973). 33p. Dep. NTIS $4.50.

The Phenix Power Plant in Marcoule now nearing completion will be the first industrial fast-neutron reactor to be built in France. The construction required a large-scale civil engineering site which had to meet a number of specific requirements: waterproof substructures with respect to the underground water table, absence of differential settlements between large-scale works, earthquake resistance, air-tight buildings, special forces to be accommodated, considerable overloads. Some original solutions were adopted: steel lining as parts of the strength of the raft and the outside walls, precase prestressed concrete panels joined by post-tension, and bonding of metal framings to prestressed or conventional structures which are partly precast. These arrangements made it possible to meet the required specifications. In particular, the tests for air-tightness of the reactor container gave full satisfaction. (auth)

4669 (ANL-Trans-995) CALCULATIONS BY TRIPOLI OF THE NEUTRON SPECTRUM IN THE LOWER SECTIONS OF THE PHENIX EXCHANGER. Nimal, J. C.; Vergnaud, T. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France)). Feb 1973. Translation of CEA-N-1579. 58p. Dep. NTIS $5.50.

Calculations were made to determine the contribution to the activation of the secondary sodium by the neutrons which escape from beneath the side neutron shield of the PHENIX reactor. In the course of this study we have also determined the complete energy spectrum from all points of view of the neutron pathways in order to compare results with those given by other methods. These latter calculations were useless as far as the activation of the secondary sodium was involved since this latter item is due only to the small numbers of neutrons which can get through the shield and still have sufficient energy. The deviations between the results given by TRIPOLI and NIOBE are due for the most part to the very different conditions under which they were calculated. The results are given. (auth)

4670 (ANL-Trans-1004) CIVIL ENGINEERING AND THE PHENIX POWER PLANT. Lacroix, R.; Magnas, J. P. Translated from Tech. Mod.; 65: 27-33(Oct 1973). 12p. Dep. NTIS $4.50.

Civil engineering problems encountered in constructing the complex buildings required for the PHENIX power plant are considered: Site problems (sealing substructures to prevent sodium leaks, protection against differential settling due to site nonhomogeneity), air-tightness of buildings, strength against earthquakes and high overloads. The permeability of various concretes is discussed. (LTN)

4671 (ANL-Trans-1005) METHODS FOR STUDYING PROBLEMS RELATED TO LIQUID SODIUM FLOWS. Constantin, J. P.; Huffenus, J. P.; Lambert, P.; Leon, P. 1972. Translation of FRNC-CONF-43. 12p. Dep. NTIS $4.50.

The methods used to study liquid metal circulation problems in sodium cooled reactors are described. The following points are emphasized: isothermal pressure and free-surface flow (head losses, cavitation, surface roughness, gas entrainment); vibration of immersed shells and structures; non-isothermal flow (heat transfer, natural and mixed convection). (8 references) (auth)

4672 (ANL-Trans-1006) HYDRAULIC PROBLEMS IN SODIUM EXCHANGERS AND REPERCUSSION IN THERMAL AREAS. Kayser, G.; Boulot, F. (CEA Centre d'Etudes Nucleaires de Cadarache, 13- Saint-Paul-les-Durance (France)). 1972. Translation of CEA-CONF-2046. 15p. Dep. NTIS $4.50.

The thermal consequences due to non-uniform flow in the inlet and outlet zones in an exchanger in a sodium reactor of the Phenix type are considered. Design variations are analyzed. (auth)

4673 (ANL-Trans-1007) FAST NEUTRON REACTORS: ADVANCEMENT FROM INITIAL RESEARCH TO THE PHENIX POWER PLANT. Vendryes, G.; Villeneuve, J.; Faure, F.; Milliat, J. P.; Rozenholc, M. 1973. Translation of CEA-CONF-2640. 20p. Dep. NTIS $4.50.

The pace of development of the fast neutron reactor in France and other countries is compared and related to the development of Light water and High temperature reactors. The various stages of acquisition of knowledge are discussed, and the present position in France is appraised: the demonstration Phenix plant will soon be completed; and the prototype 1200 MW(e) Super Phenix is on the drawing boards. The main choices adopted in the French programme are described and critically reviewed. (auth)

4674 (ANL-Trans-1008) TOWARDS COMMERCIAL FAST BREEDER REACTORS THE FIRST 1200 MWe UNIT. Banal, M.; Carle, R. (CEA Centre d'Etudes Nucleaires de Saclay, 91-Gif-sur-Yvette (France)). 1973. Translation of CEA-CONF-2641. 17p. Dep. NTIS $4.50.

The public probably thinks of these fast breeder reactors in terms of their rising unit capacity: RAPSODIE 20 MW (thermal), raised to 40 MW, PHENIX 25 MWe, and now 1200 MWe. However, the purposes of the project and the framework of construction have been fundamentally different in each case. Design parameters and the development program of the LMFBR are presented. (auth)

4675 (GA-A-13327) HEAT TRANSFER DATA BASE FOR GCFR CORE DESIGN. Hopkins, H. C. (General Atomic Co., San Diego, Calif. (USA)). 4 Sep 1975. Contract AT(04-3)-167. 28p. Dep. NTIS $4.00.

The Gas-Cooled Fast Breeder Reactor (GCFR) heat transfer data base is presented as a reference tree with the following branches: GCFR design summaries, heat transfer technology, design reviews, thermal analysis computer codes, and thermal design of other gas-cooled reactors. An extensive bibliography of published heat transfer references, arranged chronologically, and comparative data on other gas-cooled reactors are also included. (auth)

4676 (GA-A-13653) DEVELOPMENT OF COMPONENTS FOR THE GAS-COOLED FAST BREEDER REACTOR PROGRAM. Dee, J. B.; Macken, T.; Meyer, L. (General Atomic Co., San Diego, Calif. (USA)). 24 Sep 1975. Contract E(04-3)-167. 30p. (CONF-751007-5). Dep. NTIS $4.50.

From IAEA international meeting on gas-cooled reactors; Julich, F.R. Germany (13 Oct 1975).

The purpose of this paper is to present an overview of the principal component design differences, when compared with those of typical HTGRs, and the consequent influences on the GCFR component development programs. Development program plans are discussed and include those for the prestressed concrete reactor vessel (PCRV), the main helium circulator and its supporting systems, the steam generators, the reactor thermal shielding, and the fuel handling system. Facility requirements to support these development programs are also discussed. Studies to date show that GCFR component development continues to appear to be incremental in nature, and the required tests are adaptations of related HTGR test programs. (auth)

4677 (GEAP-14054) REVIEW AND EVALUATION OF CURRENT AEROSOL MODELS FOR LMFBR SAFETY ANALYSIS. Huang, T. C.; Stitt, R. K. (General Electric Co., Sunnyvale, Calif. (USA). Breeder Reactor Dept.). Jun 1975. Contract AT(04-3)-893. 52p. AT.

Aerosol behavior models were reviewed and the most significant areas of the models were assessed to determine their adequacy for LMFBR safety analysis. It is concluded from this study that the aerosol behavior models presently available can be utilized to

adequately predict aerosol behavior in the reactor containment building, providing the Stokes' correction factor, the gravitational collision efficiency and the boundary layer thickness at the wall can be determined for the size containment being analyzed. However, these models were found to need improvement and revisions before they can be used adequately for evaluation of aerosol behavior in the reactor cover gas region during an HCDA event. The state-of-knowledge as to the processes and controlling phenomena associated with the formation of aerosols from sodium fire, fuel vapor condensation, and fragmentation were studied. A variety of analytical aerosol source models were assessed and the important experimental results were summarized. (auth)

4678 (HEDL-TME--74-42) GAS RELEASE VENT PERFORMANCE DURING LMFBR IRRADIATION. Christensen, J. A. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Jul 1974. Contract AT(45-1)-2170. 54p. AT.

The use of vents to release He from boron-containing absorber pins is required to achieve substantial improvements in lifetime, performance, and cost of LMFBR control rods. Various types of vents have been evaluated in the laboratory and by testing in EBR-II. The results of in-reactor tests performed to date are described. A nineteen-pin bundle containing fourteen vented pins was irradiated in Row 7 of the EBR-II for 100 EFPD. Top and bottom diving bell type vents plus two types of capillary valve vents (porous plugs and flattened tubes) were included in the test. Results of postirradiation examination and data analyses are presented. (auth)

4679 (HEDL-SA-960(Rev.)) SOME FINDINGS FROM FFTF PIPING AND COMPONENT DESIGN ANALYSES. Severud, L. K.; Weiner, E. O.; Winkel, B. V. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Sep 1975. Contract E(45-1)-2170. 24p. (CONF-750635-1). Dep. NTIS $4.25.

From meeting of fast reactor thermal transients; Washington, District of Columbia, USA (19 Jun 1975).

A number of questions that have been commonly raised during elevated temperature design of FFTF components and pipelines are identified and discussed. Although the questions do not lend themselves to simple answers, some guidance based on analysis findings is given. Based upon the limited data developed, uniaxial stress relaxation data can give a reasonable pattern of structural creep damage as a function of time. However, the creep damage magnitude may be as much as a factor of two too low. Other geometries and/or loading may show much larger variations between the uniaxial and complex hardware creep damage response. (auth)

4680 (HEDL-SA-986) TECHNIQUES FOR STUDYING CORROSION AND DEPOSITION OF RADIOACTIVE MATERIALS IN SODIUM LOOPS. Brehm, W. F.; Chulos, L. E.; McGuire, J. C.; Leaf, A. C.; Colburn, R. P. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Sep 1975. Contract E(45-1)-2170. 40p. (CONF-750972-1). Dep. NTIS $5.00.

From IAEA specialists meeting on fission and corrosion products in primary systems of LMFBR's; Dimitrovgrad, USSR (8 Sep 1975).

Standard temperature and flow control methods are used for the test loops. Some improvements in temperature control methods for cold traps and coolers have been made and are described. Radionuclide migration through the test loops is monitored during test operation as well as during times when the loops are shutdown. The Ge(Li) diode gamma spectrometer and multichannel analyzer are calibrated using radiochemical standards in piping of identical sizes as used in the loops. An incremental analysis technique has been developed to obtain chemical and radiochemical gradients in the stainless steel test specimens. These gradients arise as the result of nonuniform corrosion of the alloy constituents of stainless steel by the sodium. A calculation method has been devised to combine the results of weight change measurements and the incremental analysis to determine the corrosion rates of each alloy constituent. 7 references. (auth)

4681 (HEDL-TME-75-89) FUEL PELLET MODELING IN THE r-z PLANE. Bard, F. E.; Watwood, V. E. Jr. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Aug 1975. Contract AT(45-1)-2170. 46p. AT.

A two-dimensional analysis of fuel pellets cracking behavior during reactor heatup and cooldown, as well as a two-dimensional analysis of fuel pellet creep behavior during a reactor steady-state operation, is presented. Startup cracking behavior was found to depend upon the creep behavior of the fuel, and coupling of these two effects must be considered in the future. The two-dimensional elastic results indicate that the one-dimensional fuel behavior resulting from plane strain assumption should be used with caution, since the end effects ("belling") of the fuel pellet influences the mid-pellet stress calculation and top edge displacements. (auth)

4682 (JAPFNR-193) PROGRESS REPORT ON FAST BREEDER REACTOR IN JAPAN, JULY–SEPTEMBER 1974. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Jan 1975. 5p. AT.

Progress on the MONJU and TOYO projects and related research programs is briefly summarized. (JWR)

4683 (KFK-2157) FRICTION AND WEAR OF BALL BEARING IN LIQUID SODIUM ENVIRONMENT. Phase 1: Material Screening Tests. Kleefeldt, K.; Gering, G. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Reaktorentwicklung). Jul 1975. 85p. (In German). Dep. NTIS (US Sales Only) $6.00.

Sodium experiments are described for ball bearings fabricated out of five different materials, i.e. tool steel (s-6-5-2), stainless high speed steel (BG 42), stellite, ferro-titanit (WF 13,5) and tungsten carbide/cobalt cermet (GE 10/20). With each material four cageless bearings of the type 6207 were tested in task 1 under the following test conditions, in order to determine the most promising material for further investigations: test temperature 400°C, axial load 300 kp, speed 200 min^{-1}, total revolutions $0,2 \cdot 10^6$, oxygen concentration <10–20 ppm. Test results are included. 26 references (auth)

4684 EMERGENCY COOLING APPARATUS FOR REACTOR. Sakaguchi, S. (to Hitachi, Ltd.). US Patent 3,900,366. 19 Aug 1975. Priority date 2 Apr 1973, Japan. 6p.

A nuclear reactor is described which has the core surrounded by coolant and an inert cover gas all sealed within a container, an emergency cooling apparatus employing a detector that will detect cover gas or coolant, particularly liquid sodium, leaking from the container of the reactor, to release a heat exchange material that is inert to the coolant, which heat exchange material is cooled during operation of the reactor. The heat exchange material may be liquid nitrogen or a combination of spheres and liquid nitrogen, for example, and is introduced so as to contact the coolant that has leaked from the container quickly so as to rapidly cool the coolant to prevent or extinguish combustion. (Official Gazette)

4685 RESTRAINT SYSTEM FOR CORE ELEMENTS OF A REACTOR CORE. Class, G. (to Gesellschaft fuer Kernforschung m.b.H.). US Patent 3,900,367. 19 Aug 1975. Priority date 15 Dec 1971, F. R. Germany. 8p.

In a nuclear reactor, a core element bundle formed of a plurality of side-by-side arranged core elements is surrounded by restraining elements that exert a radially inwardly directly restraining force generating friction forces between the core elements in a restraining plane that is transverse to the core element axes. The adjoining core elements are in rolling contact with one another in the restraining plane by virtue of rolling-type bearing elements supported in the core elements. (Official Gazette)

4686 CREYS-MALVILLE PLANT. Options and Description. Saitcevsky, B.; Casini, R.; Robert, E.; Janberg, K. G. (Societe Centrale Nucleaire Europeenne a Neutrons Rapides (NERSA), 69–Lyon (France)); Megy, J.; Crette, J. P.; Granito, F.; Leduc, J. (Societe Technique pour l'Energie Atomique (Technicatome), Centre d'Etudes Nucleaires de Saclay, 91–Gif-sur-Yvette (France)). pp 52-54 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975). (American Nuclear Society, Hinsdale, Ill.).

The main characteristics of the 1200 MW(e) Super Phenix power plant are described, including: fuel, cooling circuits, fuel assembly loading-unloading systems, and the design of the machine room. (FR)

4687 FUEL MANAGEMENT CODES FOR FAST REACTORS. Sicard, B.; Mougniot, J. C.; Pontier, M.; Skok, J. (CEA Centre d'Etudes Nucleaires de Cadarache, 13–Saint-Paul-les-Durance (France). Dept. des Reacteurs a Neutrons Rapides); Coulon, P.; Penet, F. (CEA Centre de Marcoule, 30–Bagnols-sur-Ceze (France). Service de la Centrale Phenix). pp 137 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975). (American Nuclear Society, Hinsdale, Ill.).

It is shown that the CAPHE code has been used successfully for the first successive loadings of the Phenix core, during startup and the first operating cycles. (FR)

4688 THE GAS COOLED BREEDER REACTOR, A CONCEPT BASED ON MATURE TECHNOLOGY. Chermanne, J.; Asbroeck, P. van; Sacriste, C. (Gas Breeder Reactor Association, Brussels (Belgium)). pp 50-52 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975). (American Nuclear Society, Hinsdale, Ill.).

It is shown that the development of GCFR reactors draws on direct experience from AGR and HTR reactor components and sodium cooled reactor fuel. However, complete studies and tests are required in a few fields such as: thermohydraulics, friction, corrosion in moist helium, and the fuel element venting system. (FR)

4689 PHENIX AFTER ONE YEAR IN OPERATION. Conte, F. (CEA Centre de Marcoule, 30-Bagnols-sur-Ceze (France). Service de la Centrale Phenix). pp 71-72 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975). (American Nuclear Society, Hinsdale, Ill.).

The Phenix reactor produced power for the first time on August 31, 1973. Linkage with the national network was accomplished on December 13, 1973. The operating year is presented, and main events and findings are analyzed. (FR)

4690 PROGRAM OF THE SUPER-PHENIX SODIUM EXPERIMENTS. Benoist, E.; Chouard, P.; Jacquelin, R.; Sauvage, M. (CEA Centre d'Etudes Nucleaires de Cadarache, 13-Saint-Paul-les-Durance (France). Dept. des Reacteurs a Neutrons Rapides); Allain, A.; Lion, R.; Martin, J. P. (Societe Technique pour l'Energie Atomique (Technicatome), Centre d'Etudes Nucleaires de Saclay, 91-Gif-sur-Yvette (France)). pp 54-55 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975). (American Nuclear Society, Hinsdale, Ill.).

The experimental program presented is concerned with the nuclear equipment working in sodium: development of a metallic thermal insulation to protect the lower part of the top shield of the main vessel, control rod drive mechanisms, sodium pumps, sodium intermediate heat exchangers, sodium purification, quality control of the sodium valves, and fuel handling system. (FR)

4691 INTERMEDIATE POWER FAST BREEDER PLANTS. Aubert, M. (CEA Centre d'Etudes Nucleaires de Cadarache, 13-Saint-Paul-les-Durance (France). Dept. des Reacteurs a Neutrons Rapides); Boulinier, C. (Societe Technique pour l'Energie Atomique (Technicatome), Centre d'Etudes Nucleaires de Saclay, 91-Gif-sur-Yvette (France)); Crette, J. P. (Groupement pour les Activites Atomiques et Avancees (GAAA), 92 - Le Plessis-Robinson (France)); Gauzit, M. (Groupement pour les Neutrons Rapides, 92-Le Plessis-Robinson (France)). pp 55-57 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975). (American Nuclear Society, Hinsdale, Ill.).

It is shown that it is already possible to envisage the construction of fast breeder plants of intermediate power (250 to 1200MW(e)). Up to 500MW(e), such plants would be a direct extrapolation from Phenix; above 600MW(e) they would be of the Super-Phenix type. There should not be any safety problem for both types and they should be competitive. (FR)

4692 DIGITAL SIMULATION OF THE DYNAMIC BEHAVIOR OF SODIUM COOLED FAST REACTOR POWER PLANTS. Ballay, R.; Hery, M.; Perrin, M. (Electricite de France, 92-Clamart. Dept. Etudes Nucleaires). pp 58-59 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975). (American Nuclear Society, Hinsdale Ill.).

The simulation procedure elaborated to study the Super-Phenix reactor is presented. It includes the study of steady states, regulations, incidents, starting up and stopping. In building the model three categories were considered: piping and heat exchangers, heat production installation, and other components such as pumps and valves. (FR)

4693 SYNTHESIS OF SCALE-MODEL STEAM GENERATOR TESTS PROPOSED FOR THE SUPER-PHENIX NUCLEAR POWER PLANT. Fontaine, J. P.; Llory, M.; Masse, J.; Quinet, J. L. (Electricite de France, 78-Chatou. Dept. Transferts Thermiques et Thermodynamique). pp 60-63 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975). (American Nuclear Society, Hinsdale, Ill.).

Two steam generator scale models developed for the Super-Phenix reactor are presented. A group of tests were carried out on these models with respect to thermal, stability, safety, and running performance. The results obtained disclosed no particular anomaly. Comparison of test results and calculation shows that it is possible to simulate the running of steam generators of this type under all possible load variants, including steady-state operation and during small perturbations. (FR)

4694 PROBLEMS SPECIFIC TO THE PIPING OF SODIUM-COOLED FAST BREEDER REACTORS. Vrillon, B. (CEA Centre d'Etudes Nucleaires de Saclay, 91-Gif-sur-Yvette (France). Service des Etudes Mecaniques et Thermiques); Montfort, C. (Bureau Veritas, 75-Paris (France)); Befre J. (Societe Technique pour l'Energie Atomique (Technicatome), Centre d'Etudes Nucleaires de Saclay, 91-Gif-sur-Yvette (France)); Schaller, K. (CEA Centre d'Etudes Nucleaires de Cadarache, 13-Saint-Paul-les-Durance (France). Dept. des Reacteurs a Neutrons Rapides). pp 63-65 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975). (American Nuclear Society, Hinsdale, Ill.).

A certain number of specific problems arising in connection with the sodium pipes in fast neutron reactors, especially those of large diameter, are presented. The supporting system must be designed to achieve the best compromise among stresses due to weight and various stresses of thermal origin. Large-scale experimental studies carried out on actual elements of the intermediate circuit of the Phenix reactor showed that the circuits can withstand considerable deformation collapse of the walls without danger of leakage. Protection studies against earthquakes are mentioned. (FR)

4695 BREEDING GAINS OF FAST REACTORS FUELED WITH PuO_2-UO_2 OXIDES AND COOLED WITH SODIUM. Mougniot, J. C.; Clauzon, P.; Giacometti, C.; Ravier, J.; Sicard, B. (CEA Centre d'Etudes Nucleaires de Cadarache, 13-Saint-Paul-les-Durance (France). Dept. des Reacteurs a Neutrons Rapides); Barre, J. Y. (CEA Centre d'Etudes Nucleaires de Cadarache, 13-Saint-Paul-les-Durance (France). Service des Experiences Critiques et de Physique des Reacteurs). pp 137-138 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975). (American Nuclear Society, Hinsdale, Ill.).

The calculated values of breeding gains of the French fast reactors are presented, and the uncertainties of these values are discussed. The influence of the various choices made by the designer on the breeding gain value is analyzed. The possibility of increasing breeding gains by some changes in the present core design concept chosen for the French Phenix and Super Phenix is examined. (FR)

4696 MEASURING APPARATUS FOR THE COOLANT OUTLET TEMPERATURE IN NUCLEAR-REACTOR FUEL ELEMENTS. Klein, K. W.; Rau, P. (to Siemens Aktiengesellschaft). US Patent 3,899,390. 12 Aug 1975. Priority date 14 Jun 1971, F. R. Germany. 4p.

A measuring apparatus for the coolant outlet temperature in nuclear reactor fuel elements particularly gas cooled fast breeder reactors is disclosed. The apparatus comprises a fuel element adapted to permit internal flow of coolant over the individual fuel elements with a variable choke adapted to regulate coolant flow rate. The temperature of the coolant after it passes over the fuel rods is measured by a temperature sensor which is removably mounted in an internal guide tube which passes through the fuel element and its supporting structure. (Official Gazette)

4697 APPARATUS FOR POWER AND BREEDING DISTRIBUTION MEASUREMENTS IN BREEDER REACTORS. Goldstein, N. P.; Sun, K. H. (to Westinghouse Electric Corp.). US Patent 3,899,676. 12 Aug 1975. Filed date 5 Feb 1973. 14p.

A detection system is disclosed herein for the measurement of power and breeding distribution inside a breeder reactor. Small diameter BeO balls comprising oxides of ^{235}U and ^{238}U are inserted into the reactor for activation and withdrawn to be counted in a Ge(Li) counter. Measurements of the activated fission and ^{239}Np gamma rays yield the desired distributions. (Official Gazette)

4698 CREEP AND CREEP-RUPTURE PROPERTIES OF THE NUCLEAR FUEL CLADDING TUBE FOR FAST BREEDER REACTOR IN HIGH TEMPERATURE SODIUM. Yuhara, S.; Funada, T.; Atumo, H. (Power Reactor and Nuclear Fuel Development Corp., Oarai, Ibaraki (Japan). Oarai Engineering Center); Nakajima, K. Zairyo; 24: No. 258, 240-246(Mar 1975). (In Japanese)

Creep and creep-rupture properties of seamless tubes of AISI Type-316 stainless steel with the nominal dimensions of 6.3 mm outside diameter and 0.35 mm wall thickness in flowing sodium environment under various conditions were investigated. For the examination in sodium environment, a creep testing apparatus was designed and incorporated with the two sodium loops for material tests. The sodium handling technique and the testing method up to 700°C have been established. The effects of oxygen level in flowing sodium on creep-rupture properties of tubular specimens of Type-316 stainless steel have been examined. At the oxygen levels of 5 and 10 wppm in flowing sodium, the values of creep-rupture strength under uniaxial tension at 600°, 650°, and 700°C up to about 2000 hr (the longest rupture time) are not significantly different. The rupture strengths under internal pressure and under uniaxial tension are significantly lower in flowing sodium containing 10 wppm oxygen at 700°C than in air at the same temperature. Furthermore, the decrease of rupture strength is greater as the exposure time in the sodium is longer, and it is related to the tendency of the relative increase in the minimum creep rate. This apparent reduction in rupture strength is accompanied by the significant decarburization of specimens tested, and the formation of a degraded layer in the neighborhood of the specimen surface exposed to sodium. (auth)

4699 AN EXPECTATION ON MOLTEN SALT BREEDER REACTORS. Furukawa, K. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). Genshiryoku Kogyo; 20: No. 10, 35-47(Oct 1974). (In Japanese)

A description is presented of a molten salt breeder reactor (MSBR) of 1000 MW(e) output. The plant specifications of the MSBR are shown in a table. The standard composition of fuel salt is $LiF-BeF_2-ThF_4-UF_4$(71.7-16-12-0.3 mole %), in which Li containing 99.995% enriched ^7Li was adopted for its small neutron absorption cross section. Some beneficial comments are included on: (1) the selection of liquid type fuel; (2) the adoption of fluoride as fuel salt; (3) thermal neutron type reactor; (4) candidate structural materials for molten salt; (5) necessity of graphite as moderator material; (6) molten salt as secondary coolant; and (7) technical feasibility of fuel reprocessing, and the operability, maintainability, safety and stability of the reactor. (JA)

4700 ROTARY SHIELD PLUG FOR FAST REACTOR. Imayoshi, S. (to Mitsubishi Atomic Power Industries, Inc., Tokyo (Japan)). Japanese Patent 1974-9159/B/. 17 Sep 1968. 3p. (In Japanese)

Sodium vapor generated at the surface of liquid sodium located at the upper portion of the reactor core, together with argon gas enclosed above the surface of the liquid sodium, move into the low temperature gap of the rotary plug and are condensed. The rotary plug can therefore not rotate. To overcome this defect, the present invention discloses a rotary plug which is drawn up and then returned to an initial position by means of a connecting rod laid therein. The apparatus includes a hydraulic ram which is buffered against shocks at standstill. (JA)

4701 NUCLEAR FUEL ELEMENT. Hirose, Y. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1974-32913/B/. 22 Jul 1970. 2p. (In Japanese)

A fuel element for a liquid-metal cooled fast neutron breeder reactor is disclosed in which the intervals between a surrounding spacer are reduced at those portions of the fuel rod where heat release is high and increased at portions thereof corresponding to low heat release. This arrangement is preferred over the conventional spacing distribution in which the spacers are disposed at equal intervals since overall resistance to coolant flow can be minimized without impairing the performance of the fuel element. The power of coolant pumps can therefore be reduced to facilitate operational economy. (JA)

4702 THERMAL-HYDRAULIC ANALYSIS FOR FUEL ELEMENTS WITH LIQUID-METAL COOLING. Voj, P.; Markfort, D.; Ruppert, E. Progr. Heat Mass Transfer; 179-193(1973).

Analytical and experimental studies of the thermohydraulic behavior of a fuel rod bundle cooled by steady state, single-phase flow, with special emphasis on liquid metals, are reviewed. Performance data on pressure drop, velocity distribution and mixing rate of mock-up bundles are presented. Spacer grids typical of the design of the fuel subassembly of the SNR-300 are taken into account; and the result of an illustrative calculation of the temp. field in the spacer grid area is given. (Metals Abstr.)

Research, Test, and Experimental Reactors

Refer also to abstracts 3078, 3079, 4682, and 4837.

4703 (ANCR-1170) DECONTAMINATION AND DECOMMISSIONING OF THE EBR-I COMPLEX. Topical Report No. 3. NaK Disposal Pilot Plant Test. Commander, J. C.; Lewis, L.; Hammer, R. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). Jun 1975. 24p. Dep. NTIS $4.00.

Decontamination and decommissioning of the Experimental Breeder Reactor No. 1 (EBR-I) requires processing of the primary coolant, an eutectic solution of sodium and potassium (NaK), remaining in the EBR-I primary and secondary coolant systems. While developing design criteria for the NaK processing system, reasonable justification was provided for the development of a pilot test plant for field testing some of the process concepts and proposed hardware. The objective of this activity was to prove the process concept on a low-cost, small-scale test bed. The pilot test plant criteria provided a general description of the test including: the purpose, location, description of test equipment available, waste disposal requirements, and a flow diagram and conceptual equipment layout. The pilot plant test operations procedure provided a detailed step-by-step procedure for operation of the pilot plant to obtain the desired test data and operational experience. It also spelled out the safety precautions to be used by operating personnel, including the requirement for alkali metals training certification, use of protective clothing, availability of fire protection equipment, and caustic handling procedures. The pilot plant test was performed on May 16, 1974. During the test, 32.5 gallons or 240 lb of NaK was successfully converted to caustic by reaction with water in a caustic solution. (auth)

4704 (ANCR-1249) LOFT VOLTAGE INSERTION CALIBRATION PROGRAM. Tillitt, D. N.; Miyasaki, F. S. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). Aug 1975. Contract E(10-1)-1375. 129p. Dep. NTIS $5.45.

The Loss-of-Fluid Test (LOFT) Facility is an experimental facility built around a "scaled" version of a large pressurized water (LPWR). Part of this facility is the Data Acquisition and Visual Display System (DAVDS) as defined by the LOFT System Design Document SDD 1.4.2C. The DAVDS has a 702 data channel recording capability of which 548 are recorded digitally. The DAVDS also contains a Voltage Insertion Calibration Susystem used to inject precise and known voltage steps into the recording systems. The computer program that controls the Voltage Insertion Calibration Subsystem is presented. 7 references. (auth)

4705 (CONF-750984-1) EXPERIMENTAL AND THEORETICAL INVESTIGATIONS ON THE DYNAMIC RESPONSE OF EBR-II DUCTS UNDER PRESSURE PULSE LOADING. Chopra, P. S.; Srinivas, S. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 32p. Dep. NTIS $4.75.

From ELCALAP seminar; Berlin, F.R. Germany (8 Sep 1975).

In order to assess the potential damage to hexagonal subassembly ducts (cans) that may result from rapid gas release from a failed element the EBR-II project has conducted experiments and analyses. Additional experimental and analytical investigations are now being conducted to assure fail-safety of the ducts. Fail-safety is defined as the ability of a duct to withstand pressure pulses from failed elements during all reactor conditions without damage to adjacent ducts or any other problems in fuel handling. The results of 93 EBR-II duct tests conducted primarily by Koenig have been reported previously. The results of empirical correlations of some of these tests to determine the influence of several variables on the pressure pulse experienced by a duct and on the duct deformation are presented. The variables include the type of gas contained in the simulated element (tube), the element and duct materials, the presence or absence of flow restrictors in the element, and the way gas was released. 8 references. (auth)

4706 (EUR-5380e) HIGH FLUX MATERIALS TESTING REACTOR (HFR), PETTEN. Annual Report, 1974. (Commission of the European Communities, Petten (Netherlands). Joint Nuclear

Research Center). 1975. 58p. Dep. NTIS (US Sales Only) $5.50. EUR FB 250,-.

After conversion to burnable poison fuel elements, the High Flux Materials Testing Reactor (HFR) Petten (Netherlands), operated through 1974 for 280 days at 45 MW. Equipment for irradiation experiments has been replaced and extended. The average annual occupation by experiments was 55%, as compared to 38% in 1973. Work continued on thirty irradiation projects and ten development activities. (auth)

4707 (GEAP-14057) PRELIMINARY ANALYSIS OF THE CAUSE OF FAILURES OF EXPERIMENTAL MIXED OXIDE FUEL RODS IN EBR-II. Patel, M.; Murata, R. E. (General Electric Co., Sunnyvale, Calif. (USA). Breeder Reactor Dept.). Jul 1975. Contract AT(04-3)-893. 48p. AT.

An analysis of failures recently discovered in experimental encapsulated mixed oxide fuel rods in EBR-II is described. It is concluded that the principal cause of the failures was the fuel-cladding mechanical interaction due to differential thermal expansion during the power increase produced when the radial UO_2 blanket in the reactor was replaced by a stainless steel reflector. Power increases ranging from approximately 23 percent to approximately 135 percent were estimated for the observed failure regions in the rods analyzed. The extent of damage caused by a power change depends on the operating temperature and the magnitude of temperature change. The analysis indicates that for the power changes considered in the analysis, rods operating at high temperatures are liable to fail at the top by thermal creep deformation, while rods operating at lower temperatures are liable to fail at the bottom by plastic deformation. (9 references) (auth)

4708 (GESR-2113) THERMIONIC FUEL ELEMENT IN-PILE TEST RESULTS. Gilliland, D. L.; Holtslag, D. J.; Samstad, G. L.; Street, G. (General Electric Co., Pleasanton, Calif. (USA). Nuclear Thermionic Power Operation). Nov 1968. Contract AT(04-3)-189. 152p. Dep. NTIS $7.75.

Declassified 20 Oct 1975.

A program of research and development has been directed toward the development of a nuclear thermionic fuel element and a compact thermionic reactor system. A major focus of the program has been on the irradiation of representative 3-cell thermionic fuel elements (TFEs) in the General Electric Test Reactor (GETR). Key materials and TFE components also have been under development through supporting analytical studies, out-of-pile experimentation and fabrication development, through irradiation of single cell in-pile converters (SCIPs) in the GETR, and through post-test examination of irradiated TFEs and SCIPs. The fabrication, test operation and pertinent post-operational examination results are described for the five 3-cell, 1-inch TFEs and four SCIPs tested in the period of this status report. (auth)

4709 (HEDL-TME-75-92) SODIUM FROST OBSERVATIONS IN CRCTA: IVHM PENETRATION PLUG. Currie, A. J. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Aug 1975. Contract AT(45-1)-2170. 18p. AT.

Sodium frost formations on the In-Vessel Handling Machine (IVHM) penetration plug are described. This plug, installed in the Composite Reactor Components Test Activity (CRCTA) to close and insulate the IVHM penetration in the absence of the IVHM component, was exposed to sodium vapor for 210 days. During plug residence, the CRCTA sodium pool temperatures ranged between 350^0F and 1100^0F. Inspection of the plug immediately following removal revealed sodium frost deposited over the entire in-vessel surface. Most of the frost appeared as a fine, grayish-white powder, distributed evenly over the top and bottom one-third sections of the plug. A band of more concentrated frost, deposited in rough beads and drip-patterned configurations, was observed around the plug midsection. Sodium frost was also observed on the CRCTA nozzle flange, deposited in crustlike formations, as well as in the O-ring grooves in the flange. A detailed comparison of the annular profiles of the CRCTA/IVHM plug and CRCTA/IVHM test component is made, followed by predicted patterns of sodium frost formation on the IVHM test component. Implications for FFTF operations are also discussed. (auth)

4710 (JINR-P3-9122) NEUTRON RADIOGRAPHY IN THE BEAM OF THE REACTOR IBR-30. Zeman, J.; Simane, C. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1975. 10p. (In Russian). Dep. NTIS (US Sales Only) $4.50.

The use of the IBR-30 reactor for studies of neutron field configurations by neutron radiography similar to those described in Kernenergie, 16, 376 (1973) has been demonstrated. (auth)

4711 TRANSIENT OPERATION EXPERIMENT OF FAST REACTOR YAYOI. An, Shigeriro; Tamura, T.; Furuhashi, A.; Wakabayashi, H. (Tokyo Univ. (Japan). Nuclear Engineering Research Lab.). Tokyo Daigaku Kogakubu Kiyo, A; No. 11, 48-49(Dec 1973). (In Japanese)

YAYOI (a fast neutron source reactor of the University of Tokyo) is a 2 kW air cooled fast reactor which is intended to be operated as a fast pulsed reactor. As the first step, transient operation experiments were made using several kinds of pile oscillator. Reactivity worths of the pile oscillator elements were measured. Some kinetic results using the elements agree with calculations. (auth)

4712 MEASUREMENTS OF TERRESTRIAL GAMMA-RADIATION AROUND RESEARCH REACTOR INSTITUTE. Katsurayama, K.; Tsujimoto, T. (Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst.). Genshiryoku Kogyo; 20: No. 5, 29-34 (May 1974). (In Japanese)

The purposes of environmental radiation dose measurement around reactor facilities are the following: (a) measurement for release control in normal operation, (b) measurement corresponding to background and community's character, (c) measurement for abnormal release control and for accident countermeasure, and (d) measurement for the evaluation of human exposure. AEC(U.S.) has proposed the severe value of 5 mrem/year as the whole body exposure of the people living around light water reactors for power generation. This requires the low-level measurement of approximately 1% of natural radiation, along with background measurement. The radioactive gas released from research reactors consists of mainly Ar-41. Present exposure around the Kyoto university reactor site due to Ar-41 was calculated to be about 0.4 to 1.0 μR/h. The radiation monitoring instruments being used or planned in the Kyoto university reactor institute are listed. Advantages and disadvantages for each type of detector used are described. The systems now being investigated elsewhere are introduced as future monitoring methods. (JA)

4713 UNIFORM HIGH-TEMPERATURE IRRADIATION METHOD OF A MATERIAL SAMPLE IN A REACTOR CORE. Hayashi, T. (to Japan Atomic Energy Research Inst., Tokyo). Japanese Patent 1973-41520/B/. 6 Sep 1969. 3p. (In Japanese)

A method is disclosed to eliminate the effects of non-uniform gamma ray distribution at the core of a nuclear reactor and achieve uniform high-temperature irradiation of a material sample. A double walled capsule consisting of an inner and outer cylinder is employed in which the outer diameter of the inner cylinder along a prescribed length at both ends thereof is somewhat smaller than the outer diameter of the central portion such that the width of the gap between the cylinders is relatively greater along the end portions. The material samples are symmetrically distributed lengthwise within the inner cylinder which is then filled with a material having a high thermal conductivity enclosed between adiabatic end caps. The capsule is inserted within the reactor core and its central portion is aligned to conform with the position of maximum gamma heat release. Due to the fact that heat reduction along the ends of the capsule is offset by the relatively larger thermal resistance at the central portion while utilization of the thermally conductive material tends to create uniform temperature, irradiation at a uniform high temperature can be effected despite the nature of the uneven gamma ray distribution. (JA)

Propulsion and Package Reactors

Refer also to abstracts 4840, 4848, and 4910.

4714 (AGC-62-02(Vol.2)(App.19)) NERVA NOZZLE COATING PROGRAM, PHASE I. Gustafson, K. L. (Aerojet-General Corp., Sacramento, Calif. (USA)). 5 Jan 1962. 26p. Dep. NTIS $5.00.

Declassified 29 Sep 1975.

Phase I of the NERVA Nozzle Coating Program involved testing of ten promising coating systems developed to date which would be compatible with a nuclear environment and hydrogen exhaust gas, based upon laboratory screening tests and in-service coated hardware. The results of these screening tests are reported. (auth)

4715 (AGC-0716(01)SP) NERVA ENGINE EXPLOSIVE DESTRUCT, SYSTEM, SUBTASK 1.6.5 POSTOPERATION DESTRUCT. (Aerojet-General Corp., Downey, Calif. (USA)). 19 Mar 1963. 67p. Dep. NTIS $5.50.

Declassified 18 Sep 1975.

The present postoperation destruct criteria specify transformation of the entire mass of fueled core elements into fragment sizes of $^1/_{32}$ in. or less prior to re-entry into the

earth's atmosphere. Of the numerous Postoperation Destruct System (PODS) concepts investigated to date, only one type indicates possible achievement of the present destruct criteria: The Mark D or Mark J type. The test results indicate that, despite the difficulty in interpreting the numerous parametric relationships involved in this emphirical study, four to six projectiles fired into the core containing approximately 300 lb of high explosive should produce an average particle size on the order of the $\frac{1}{32}$-in. value if the core material were of the KIWI B-4 configuration. (auth)

4716 (AGC-0716-16(03)MP) NERVA ENGINE EXPLOSIVE DESTRUCT SYSTEM, SUBTASK 1.6. Monthly Progress Report for December 1962. (Aerojet-General Corp., Downey, Calif. (USA)). Dec 1962. 116p. Dep. NTIS $6.50.

Declassified 18 Sep 1975.

The basic fragmentation research subtask supports the anticriticality and postoperation destruct subtasks by supplying back-up information, by determining fundamental fracture characteristics of graphite, and, if possible, by indicating a method for pulverizing the reactor core material. Four primary areas under consideration are the mechanical properties of graphite, the characteristics of explosively initiated fracture, the characteristics of mechanically initiated fracture, and the effect of acoustical energy inputs upon graphite test specimen. Twelve explosive tests were conducted. (auth)

4717 (AGC-0716-16(07)MP) NERVA ENGINE EXPLOSIVE DESTRUCT SYSTEM, SUBTASK 1.6. Monthly Progress Report for April 1963. (Aerojet-General Corp., Downey, Calif. (USA)). 3 May 1963. 92p. Dep. NTIS $6.00.

Declassified 24 Sep 1975.

A series of subscale tests on the Anticriticality and Postoperation Destruct Systems was carried out to supply preliminary information in support of forthcoming full scale tests. Fragmentation of graphite rods by mechanical impact was studied. Further experiments on the effects of radiation on chemical explosives were carried out. An evaluation and analysis of the overall operational inter-relationships of the various candidate destruct systems was made. A parametric trade-off study was made of the anticriticality destruct system concept. A preliminary feasibility study was done of a closed breech gun design for anticriticality destruct system application. Eighteen tests were conducted in specified areas of investigation. (auth)

4718 (AGC-0716-16(08)MP) NERVA ENGINE EXPLOSIVE DESTRUCT SYSTEM, SUBTASK 1.6. Monthly Progress Report for May 1963. (Aerojet-General Corp., Downey, Calif. (USA)). 4 Jun 1963. 186p. Dep. NTIS $8.50.

Declassified 30 Sep 1975.

Full-scale explosive tests in support of the Anticriticality and Postoperation Destruct Systems were carried out. The reliability of the more promising systems was investigated. Other work involved a study of shock waves from explosions and the development of needed instrumentation. (LTN)

4719 (AGC-0716-16(10)MP) NERVA ENGINE EXPLOSIVE DESTRUCT SYSTEM, SUBTASK 1.6. Monthly Progress Report for July 1963. (Aerojet-General Corp., Downey, Calif. (USA)). 4 Aug 1963. 131p. Dep. NTIS $7.00.

Declassified 7 Oct 1975.

Plans for two major ACDS evaluation tests were submitted for approval. Test PO-91 was conducted to ascertain the effects of nonsimultaneous initiation upon the fragmentation capabilities the multiprojectile Mark D concept. Results indicated that a short, incidental 3.5-msec delay in initiation from charge to charge or a total delay of 7.5 msec from Charge 1 to Charge 4 would not have a deleterious effect upon PODS capabilities. Four tests were conducted as a part of the continuing series of explosive fragmentation experiments. Preliminary tests in the study of shock propagation in graphite have been completed. Two shockwave time-of-arrival tests, on a larger scale than previous tests, were conducted. Test results provided more data on rise time of the shockwave, and data from the rasteroscilloscope were in good agreement with previous data; however, beyond 4 in. from the projectile, the data were inconsistent and erratic. The continuing literature survey has provided invaluable information on shock propagation and the Hugoniot's equation-of-state of commercial graphite. Continued effort was directed toward the design, analysis, and study of the most promising candidate destruct systems and to formulate characteristics of both the ejectable ACDS and the bifunctional destruct system. (auth)

4720 (AGC-746-14) PARAMETRIC STUDY AND PRELIMINARY DESIGN OF A CONVERGENT CONICAL NOZZLE. Richie, C. C. (Aerojet-General Corp., Sacramento, Calif. (USA)). Nov. 1963. 93p. Dep. NTIS $6.00.

Declassified 22 Sep 1975.

A parametric study of various convergent conical nozzle configurations is presented in order to investigate their feasibility as a backup for the current NERVA nozzle. The governing design load condition is a uniform internal pressure loading which occurs during proof test. Nozzle configurations are an unsupported tube bundle, a tube bundle supported by a conical frustrum, and a tube bundle reinforced by means of circumferential bands and meridional tubes. Nozzle geometry includes cone half angles of 5°, 15°, 25°, 35° and 45°. Materials considered are 347 CRES, 19-9 DL, Hastelloy C, A-286, Inconel X750 and Inconel 718. A cone half angle of 45° and Inconel 718 is selected for the preliminary nozzle design. A design is evolved and analysis indicates a high degree of reliability of construction may be achieved. A design of this nature is recommended as backup for the current NERVA nozzle system. (auth)

4721 (AGC-1861) EXPERIMENTS ON, AND ANALYSES OF, THE DYNAMICS OF A TOPPING TURBINE CYCLE FOR APPLICATION TO NUCLEAR ROCKET ENGINES. Period covered: 15 May 1959-15 June 1960. (Aerojet-General Corp., Azusa, Calif. (USA)). 1 May 1961. 226p. Dep. NTIS $9.00.

Declassified 11 Sep 1973.

The results are summarized of a program of analyses and tests made to determine methods for predicting from steady-state test data the dynamic characteristics (including engine bootstrap capabilities, controllability, and stability) of a model topping-cycle nuclear-rocket propellant-feed system. Liquid nitrogen was used as the working fluid for the model feed system. However, analyses were also made for systems operating on liquid hydrogen. Provisions of the work schedule necessitated simultaneous execution of the analytical and experimental phases of the effort. Consequently, a nitrogen-engine analog, based on the model-engine design specification, was developed at the same time that the model engine was being fabricated. The nitrogen-engine analog was used to secure analytical data for a variety of operating conditions which were later obtained in the model engine. A hydrogen-engine analog based on the model-engine hardware specifications was also developed. Comparison of data from these two simulated engines provided the means for determining the significance of the effect of fluid properties on engine operation. Model-engine component characteristics were determined experimentally. Engine test data were obtained for a variety of operating conditions throughout the bootstrap and normal operating ranges and used to improve the simulation of the model-engine system. Final computer data were compared with engine test results in order to verify the theory implied in the development of the analog. This comparison demonstrates that the principles of dynamic operation of topping-cycle engines, on which the final engine analog development is based, constitute a valid theory of topping-cycle engine operation. (auth)

4722 (AGC-2314) SELECTED TERMINOLOGY AND DATA APPLICABLE TO NUCLEAR PROPULSION AND SPACE TRAVEL WITH SPECIAL REFERENCE TO THE NERVA PROGRAM. Blue, H. M. (Aerojet-General Corp., Sacramento, Calif. (USA)). Mar 1964. 388p. Dep. NTIS $11.75.

Definitions and/or explanations are provided for terminology used in nuclear propulsion and space flight. (LTN)

4723 (AGC-2481) PRESSURE VESSEL-REACTOR INTERFACE LOADS REPORT. (Aerojet-General Corp., Azusa, Calif. (USA)). Feb 1963. 11p. Dep. NTIS $4.50.

Declassified 18 Sep 1975.

The present arrangement of reactor components is similar to Arrangement Four, as described in Westinghouse Report WANL-TNR-046. In this arrangement, the entire core load is supported by the outer reflector support ring, which in turn is supported by the pressure vessel at the junction of the pressure vessel and the forward closure. The inner reflector is the only reactor component not supported by this ring. The main support structures and the loads imposed on them are shown for 6 conditions of different axial and lateral acceleration (or deceleration). (auth)

4724 (AGC-2510(Vol.5)) RADIATION EFFECTS TESTING. (AEROJET-GENERAL CORP., SACRAMENTO, CALIF. (USA)). May 1963. 99p. Dep. NTIS $6.00.

Declassified 24 Sep 1975.

Test plans, specifications and some preliminary test reports of 12 radiation effects tests of various electronic components have been compiled. (LTN)

4725 (AGC-2785) NUCLEAR ANALYSES FOR CONCEPTUAL DESIGN. Engine Test Stand No. 2. (Aetron, Covina, Calif. (USA)). Jan 1964. 87p. Dep. NTIS $6.00.

Declassified 17 Sep 1975.

Nuclear analyses have been conducted to determine the engineer-

ing requirements and nuclear radiation compatibility of conceptual designs of Engine Test Stand No. 2 to be located at the Nuclear Rocket Development Station, Jackass Flats, Nevada. Data developed as a result of these analyses are provided and engineering guidelines to be used in subsequent design efforts for this test stand are indicated. (auth)

4726 (AGC-8207-63-9) NERWI HYDROSTATIC TEST STRUCTURAL EVALUATION REPORT. Thomas, R. W. (Aerojet-General Corp., Sacramento, Calif. (USA)). Sep 1963. 182p. Dep. NTIS $8.50.

Declassified 30 Sep 1975.

A hydrostatic test of an ACF Industries pressure vessel-Aerojet-General Corporation hybrid nozzle was performed to verify experimentally the compatibility of the pressure vessel-nozzle attachment joint. The test assembly reached maximum pressures of 680 psig in the pressure vessel zone and 565 psig in the nozzle zone at which time a premature failure of the nozzle shear lip occurred. A failure analysis has been conducted and reported; failure was due to low mechanical properties in the nozzle jacket. Compatibility of the assembly was demonstrated with the qualification that mechanical properties of the nozzle jacket be improved. Considerable data were obtained for correlating with the analysis and for design improvement. The method of analysis was basically verified. (auth)

4727 (AGC-8207-63-21) NRX-A PRESSURE VESSEL METALLIC SEALS. Test Series I, Evaluation Report. Locke, J. N. (Aerojet-General Corp., Sacramento, Calif. (USA)). 29 Jan 1964. 76p. Dep. NTIS $6.00

Declassified 30 Sep 1975.

Pneumatic tests of pressure vessel metallic seals successfully demonstrated the integrity of pressure vessel closure S/N 002 which had undergone repairs at the vendor's facility and evaluated three sets of one seal configuration designed to limit helium gas leakage to less than 10^{-2} standard cubic centimeters per second, per inch of diameter, at proof pressure of 645 psig. The quantity of leakage measured differed considerably from set to set because of variations in test conditions, seal groove cleanliness and seal to seal variation. In view of the difficulty in meeting it, the design requirement for leakage to be less than 10^{-2} standard cubic centimeters per second per inch of diameter should be re-evaluated. (auth)

4728 (AGC-9443-63-7(1)) DEVELOPMENT TEST REPORT OF KIWI-B AND HYBRID NOZZLES. (Aerojet-General Corp., Azusa, Calif. (USA)). 22 Mar 1963. 105p. Dep. NTIS $6.50.

Investigations were undertaken for the purpose of identification of causes which led to failure of the cast aluminum jackets of two nozzles subjected to structural testing which was expected to be of a non-destructive nature. Part I is devoted to pertinent pretest events, failure, and investigations related to the Kiwi-B nozzle. Part II covers similar aspects pertaining to the Hybrid nozzle. The evaluation of the failures has led to the conclusion that the development of a casting technique for the nozzle-jacket configuration presents a greater problem than anticipated. In arriving at a solution to this problem, various areas of investigation have been undertaken. They include gating techniques, cooling procedures and control of flow (change in gate flow areas). In support of vendor and in-house effort, consultants from the aluminum industry were utilized. (auth)

4729 (AGC-9443-63-7(2)) FAILURE REPORT OF KIWI-B AND HYBRID NOZZLES. (Aerojet-General Corp., Sacramento, Calif. (USA)). 22 Mar 1963. 106p. Dep. NTIS $6.50.

Declassified 30 Sep 1975.

During the hydrostatic test of the Kiwi-B nozzle, S/N 002K, the aluminum jacket failed after holding 800 psig for 3 minutes. The two longitudinal ruptures coincided with the positions of two of the four vertical in-gates of the casting mold. The post-failure metallurgical investigation established that general gas porosity prevailed throughout the cast jacket. The elongation in the non-fractured areas ranged from 1% to 4%, predominately 2%. The fractured zone exhibited 0.16% elongation and zero elongation was established for the failure origin zone. This low ductility characteristic, i.e., no yielding before failure, explains why the strain gages used during the hydrotest gave no indication of the incipient failure. The chemical composition of the A356 alloy was found to conform with the specification. The defective areas were of needle-like eutectic structure and contained considerable coarseness, thus contributing to low ductibility and lack of strength as well. The failure of the shear lip of Hybrid nozzle S/N 001H occurred during the Nerwi Hydrostatic Test. Subsequent chemical, metallurgical, and stress investigations were made to establish the cause. Structural failures suffered by the Kiwi-B, S/N 002K, and Hybrid, S/N 001H, nozzles resulted from poor mechanical properties of the A356 aluminum castings. Poor casting quality tends to concentrate in the proximity of the casting mold in-gates. Vertical gating system yields casting quality inferior to that obtained with horizontal gating system when used for casting of objects of the size and configuration under consideration. Minimum tensile yield strengths of 20 ksi can be obtained throughout the jacket utilizing a horizontal gating system and existing casting procedures. (auth)

4730 (L-0560-10-1) INFORMAL MONTHLY PROGRESS LETTER NO. 1 TO AEC-NASA NUCLEAR PROPULSION OFFICE FOR PROJECT NERVA. Period Covered: 10 June-31 July 1961. (Aerojet-General Corp., Azusa, Calif. (USA)). 1961. 20p. Dep. NTIS $4.50.

Declassified 23 Sep 1975.

The work effort in this first report period has been directed toward organizing, planning, and initiating the Phase I program. Also, technical effort has commenced on all items of the Work Statement. Planning and technical sessions between Aerojet and Westinghouse have been held to clarify the objectives in the areas of control, general reactor arrangement, and shielding. Discussions with LASL concerning the technical aspects of reactor design, fuel fabrication and reactor control have also taken place. A procedures manual to guide the operations between Aerojet, Westinghouse, SNPO, other sub-contractors, and participants has been prepared and is being reviewed by the principal program participants. A preliminary master engine-layout drawing of the NERVA heated-bleed cycle engine was initiated, and is 50% completed. Reactor component designs are being evaluated and problem areas identified and defined. Work was initiated on the analysis and design of a second generation reactor simulator. (auth)

4731 (L-0560-10-3) INFORMAL MONTHLY PROGRESS LETTER NO. 3 TO AEC-NASA NUCLEAR PROPULSION OFFICE FOR PROJECT NERVA. Period covered: 1 September-30 September 1961. (Aerojet-General Corp., Azusa, Calif. (USA)). 1961. 48p. Dep. NTIS $5.00.

Declassified 23 Sep 1975.

Progress in the design and testing of reactor components is reported. Installation and checkout of the first generation reactor simulator was completed; the design of a second generation engine simulator continued and some attention was given to the requirements of a third generation simulator. (LTN)

4732 (L-0560-10-4) INFORMAL MONTHLY PROGRESS LETTER NO. 4 TO AEC-NASA NUCLEAR PROPULSION OFFICE FOR PROJECT NERVA. Period covered: 1 October-31 October 1961. (Aerojet-General Corp., Azusa, Calif. (USA)). 1961. 54p. Dep. NTIS $5.50.

Declassified 23 Sep 1975.

Work involved preliminary design studies of the NERVA reactor and of its critical components and some testing of the latter (bearings and seals). KIWI nozzle development is summarized. Considerable effort was devoted to the better definition of the complete engine development, necessary associated activities, environmental specifications and analysis of alternative design approaches and the way they fitted into the overall design. The preliminary design was evaluated by mockups, reactor simulators, design reviews and analysis of particular problems (radiation heating, neutron activation; propellant fuel system, tank pressurization system, decay heat removal, shielding, instrumentation and control systems, etc.). (LTN)

4733 (L-0560-10-7) INFORMAL MONTHLY PROGRESS LETTER NO. 7 TO AEC-NASA SPACE NUCLEAR PROPULSION OFFICE FOR PROJECT NERVA. Period covered: 1 January-31 January 1962. (Aerojet-General Corp., Azusa, Calif. (USA)). 1962. 64p. Dep. NTIS $5.50.

Declassified 24 Sep 1975.

Analysis, design, and testing of the various engine components and sub-assemblies continued as scheduled. The preparation of the Test Stand ETS-1 Facility Instrumentation and Control Design Criteria was completed and most of the five volumes distributed. The design, analysis, fabrication and testing of components of a reactor simulator progressed. Wood mockups of preliminary designs are being completed. Test facility progress is summarized and many other items are considered briefly. (LTN)

4734 (L-0560-10-8) INFORMAL MONTHLY PROGRESS LETTER NO. 8 TO AEC-NASA SPACE NUCLEAR PROPULSION OFFICE FOR PROJECT NERVA. Period covered: 1 February-28 February 1962. (Aerojet-General Corp., Azusa, Calif. (USA)). 1962. 99p. Dep. NTIS $6.00.

Declassified 24 Sep 1975.

The master engine layout drawings, the engine installation drawings, the engine assembly drawings, the planning parts lists, and a preliminary diagrammatic flow chart of assembly and

disassembly for the heated-bleed cycle and hot-bleed cycle E-engines were issued to supporting groups and subcontractors. The first version of Specification AGC-10097A, for the AJ31-6 Heated-Bleed Engine, and the second revision of Specification AGC-10095B, for the AJ30-5 Hot-Bleed Engine, both incorporating final Phase I engine requirements, were completed and issued, as was the first issue of the Interface Specification, AGC-10119, which defines the interface requirements between the Heated-Bleed and Hot-Bleed Engine and the vehicle, and between the engines and test stand (ETS-2). The Generation-II engine simulator is being fabricated and plans for its use in evaluating reactor kinetics, heat transfer, pressure drop and control system problems have been formulated. Other design study and component testing results are reported. (LTN)

4735 (L-0560-10-12) AEC-NASA SPACE NUCLEAR PROPULSION OFFICE INFORMAL MONTHLY PROGRESS LETTER NO. 12, JUNE 1962. Project NERVA. (Aerojet-General Corp., Azusa, Calif. (USA)). 1962. 139p. Dep. NTIS $7.00.
Declassified 23 Sep 1975.

4736 (L-0560-10-13) AEC-NASA SPACE NUCLEAR PROPULSION OFFICE PROJECT NERVA. Informal Monthly Progress Letter No. 13, July 1962. (Aerojet-General Corp., Azusa, Calif. (USA)). 1962. 142p. Dep. NTIS $7.00.
Declassified 22 Sep 1975.

4737 (L-0560-10-14) INFORMAL MONTHLY PROGRESS LETTER NO. 14 TO AEC-NASA SPACE NUCLEAR PROPULSION OFFICE FOR PROJECT NERVA. Sevadjian, E. M. (Aerojet-General Corp., Azusa, Calif. (USA)). Aug 1962. 134p. Dep. NTIS $7.00.
Declassified 22 Sep 1975.

4738 (L-0560-10-16) INFORMAL MONTHLY PROGRESS LETTER NO. 16 TO AEC-NASA SPACE NUCLEAR PROPULSION OFFICE FOR NERVA PROGRAM. White, E. L. (Aerojet-General Corp., Azusa, Calif. (USA)). Oct 1962. 157p. Dep. NTIS $7.75.
Declassified 18 Sep 1975.

4739 (L-0560-10-17) INFORMAL MONTHLY PROGRESS LETTER NO. 17 TO AEC-NASA SPACE NUCLEAR PROPULSION OFFICE FOR NERVA PROGRAM. Period covered: November 1962. (Aerojet-General Corp., Azusa, Calif. (USA)). 1962. 170p. Dep. NTIS $7.75.
Declassified 30 Sep 1975.
Progress related to NRX-A1 and KIWI B-5 reactors is reported, especially with respect to valves, turbopumps, bearings, fuel elements, pressure vessels, nozzles, etc. Considerable effort has been devoted to the critical problems involved in providing the test stand exhaust system within a schedule satisfactory to current reactor testing plans. Radiation effects programs have been planned. (LTN)

4740 (L-0560-10-18) INFORMAL MONTHLY PROGRESS LETTER NO. 18 TO AEC-NASA SPACE NUCLEAR PROPULSION OFFICE FOR NERVA PROGRAM. Period covered: December 1962. (Aerojet-General Corp., Sacramento, Calif. (USA)). [nd]. 170p. Dep. NTIS $7.75.
Declassified 2 Oct 1975.
Program revisions were necessary to concentrate development efforts upon a Hot-Bleed engine cycle rather than on the Heated-Bleed engine cycle. At a subsequent meeting at SNPO-C representatives of SNPO and REON discussed the contents of the preliminary version of Report 2434, and arrived at general concurrence with the program as defined therein. Development work on the NERVA engine is now being devoted solely to the Hot-Bleed engine cycle. Because of the critical problems associated with providing the Test-Stand Exhaust System for the Engine-Test facilities at NRDS in a time schedule that is compatible with engine test plans, considerable effort has been devoted to the analysis and planning of appropriate actions. Emphasis has been given to the definition of the Radiation Effects Test Program. A revised program, including a technical discussion, test schedule, and test plans for Contract Year 1963 was prepared and delivered to SNPO-C. The document included five-year radiation effects test schedules. This document is currently being reviewed and evaluated by SNPO-C. Technical direction and review meetings continue to be conducted with all program participants, following the same procedures as outlined in previous monthly reports. These meetings continue to serve as useful forums for the interchange of technical information and as timely mechanisms for the establishment of action items to expedite the achievement of overall goals and objectives. (auth)

4741 (L-0560-10-19) AEC-NASA SPACE NUCLEAR PROPULSION OFFICE NERVA PROGRAM. Informal Monthly Progress Letter No. 19, January 1963. (Aerojet-General Corp., Azusa, Calif. (USA)). 1963. 183p. Dep. NTIS $8.50.
Declassified 18 Sep 1975.
Progress in the development and fabrication of NRX-A1 and KIWI reactors is reported, mainly with respect to valves, turbopumps and their bearings, nozzles, pressure vessels and fuel elements. Test facilities are being prepared to test reactors and critical components. Some attention has been given to methods of fragmenting in space a malfunctioning reactor or at the end of its useful life. On the basis of an examination of the overall program, a major redirection was carried out to place more emphasis on reactor analysis and development with a concomitant stretch-out in non-nuclear development efforts. (LTN)

4742 (L-0560-10-20) AEC-NASA SPACE NUCLEAR PROPULSION OFFICE NERVA PROGRAM. Informal Monthly Progress Letter No. 20, February 1963. (Aerojet-General Corp., Azusa, Calif. (USA)). 1963. 191p. Dep. NTIS $8.50.
Declassified 2 Oct 1975.
Developments related to the NRX-A1 and KIWI reactors are reported, especially with respect to turbopumps, bearings, actuators, fuel elements, pressure vessels and nozzles. (LTN)

4743 (L-0560-10-22) AEC-NASA SPACE NUCLEAR PROPULSION OFFICE NERVA PROGRAM. Informal monthly progress letter No. 22, April 1963. (Aerojet-General Corp., Azusa, Calif. (USA)). 1963. 225p. Dep. NTIS $8.75.
Declassified 26 Sep 1975.
Progress in the design and fabrication of the NRX-A1 and NRX-A2 reactors is reported, especially with respect to turbopumps (and their bearings), nozzles and values. Test facility modifications are discussed. (LTN)

4744 (L-0506-10-24) AEC-NASA SPACE NUCLEAR PROPULSION OFFICE NERVA PROGRAM. Informal Monthly Progress Letter No. 24, June 1963. (Aerojet-General Corp., Azusa, Calif. (USA)). 1963. 255p. Dep. NTIS $10.00.
Declassified 24 Sep 1975.
A round trip shipping demonstration of a dummy reactor core by special train shipment was completed to obtain environmental data on acceleration and shock loads. In order to ensure that the future test efforts at NRDS on the NRX-A1, -A2, and -A3 will be monitored properly, an NRX-A1 Task Force has been established. This group has been charged with the continuous review of critical areas including design, fabrication, assembly, test planning, and NRDS operation. A somewhat similar group, the Nozzle Task Force, has been formed to resolve the nozzle casting problems. Principally, the nozzle casting problems consist of obtaining the required physical properties for the nozzle castings, particularly elongation of the nozzle jacket. Acceptable quality castings have been obtained with respect to the ultimate and yield strengths. To date, acceptable elongation properties have not been obtained. Elongation values in the range of 6 to 8% are desired, while values of 2 to 4% have been obtained. A successful test was conducted of the Mk III Mod 3 TPA at near FX power and under hot turbine gas conditions (excess of 1200°R). Design work proceeded on the conceptual layout of the Mk IV Mod 2 TPA, which includes provisions for sealing the pump. This re-direction was specified by SNPO-C in order that only minor TPA revisions would be required in the event that it became necessary to accomplish a "wet pump" start-up. Qualification tests of the NRX-A reactor shipping container have been completed. The results indicate that the shipping container satisfies all specification requirements. (auth)

4745 (L-0560-10-25) AEC-NASA SPACE NUCLEAR PROPULSION OFFICE NERVA PROGRAM. Informal Monthly Progress Letter No. 25, July 1963. (Aerojet-General Corp., Azusa, Calif. (USA)). 1963. 237p. Dep. NTIS $9.00.
Declassified 19 Sep 1975).
Extensive efforts were directed towards preparation of the Program Plan for CY 64. A preliminary draft of Revision D of the FX Model Specification (S-RD) was submitted to SNPO-C. This major revision and updating of the Engine Specification will be issued in final form after review by SNPO-C. A new thrust bearing design was evaluated at 16,000 rpm in the turbine tester, performing satisfactorily with an Armalon thin line cage for 9.2 minutes at a thrust load of 2000 lb. Preliminary results of the three hydrostatic test phases on the titanium pressure vessel indicate that all objectives were achieved. A round-trip shipping demonstration test of a dummy reactor was successfully conducted between the Astronuclear Laboratories at Large, Pa., and the MAD Building at NRDS. Orificing and clustering for Phase I vibration reactor has been completed, and all clusters have been assembled into the core. All unloaded core elements for the NRX-A1 core, including elements modified for instrumentation, were received from UCNC, and 80% of the loaded elements for

NRX-A2 core are not in process. Two failures of the dynamic shaft seal used on the TPCV actuator occurred during room-temperature acceptance testing. Alternate seal configurations are being manufactured and tested to prevent future failures. The NRX-A1 Operational Support Plan was issued. (auth)

4746 (L-0560-10-26) AEC–NASA SPACE NUCLEAR PROPULSION OFFICE NERVA PROGRAM. Informal Monthly Progress Letter No. 26, August 1963. (Aerojet-General Corp., Azusa, Calif. (USA)). 1963. 256p. Dep. NTIS $9.00.
Declassified 19 Sep 1975.
Major efforts were directed toward the preparation and submittal of the Program Plan for Contract Year 1964. A design review meeting relative to the NRX-B engine was held at WANL for the purpose of reviewing the design status, and for discussion and selection of particular designs for further investigation. The banded core concept was approved by SNPO and REON, and adopted by WANL. A turbopump bearing set was satisfactorily operated in a turbopump at design rated load and speed for 5 minutes, utilizing LH_2 as the lubricant. Initial static tests, under full-load conditions, were satisfactorily conducted on the upper and lower thrust structures, and the pressure vessel. To further implement the sufficiency and concept of Safety in the NERVA Program, a separate Safety Division has been established in REON, reporting to the Director's Office. (auth)

4747 (NDC-18B) NERVA DESIGN CRITERIA: SIMULATOR, GENERATION II, NUCLEAR ROCKET ENGINE, HEATED-BLEED, AJ31-6. Booth, F. M. (Aerojet-General Corp., Azusa, Calif. (USA). 27 Jul 1962. 17p. Dep. NTIS $4.50.
Declassified 14 Oct 1975.

4748 (NTO-R-0079) NRX/EST POST TEST REPORT. (USA). 1966. 215p. Dep. NTIS $8.75.
Declassified 24 Sep 1975.
The NRX/EST disassembly operation was performed at the R-MAD Facility at NRDS. All sub-assemblies were dismantled for final observation. Routine hot cell operations have been completed; replication, annealing, and fatigue studies are in the final stages of completion at NRDS. Metallography and special examinations are being completed at CMB-14, LASL, New Mexico. The results noted during the post-test operations and the experience gained during the test series have confirmed the ability of the NRX/EST total system to operate at conditions of design point power for extended periods of time and have provided valuable data applicable to the design of future engine systems and reactor components. As in the previously tested NRX test assemblies, no damage related to full power testing was apparent in the non-fuel subsystems. The major test effect occurred in the core region where a portion of the fuel elements were damaged by surface and internal channel corrosion, pinholing, channel exposure, and melting. (auth)

4749 (NTO-R-0097) NRX-A5 POST TEST REPORT. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 1966. 186p. Dep. NTIS $8.50.
Declassified 24 Sep 1975.
Post test disassembly of the NRX-A5 Test Assembly was performed at the R-MAD facility at NRDS. As with previous test assemblies, no significant damage related to full power testing was apparent in the non-nuclear hardware or the outer reflector assembly. Damage was basically confined to the fueled region, with the following observations specifically noted: high weight loss from corrosion of fuel elements in the central core region; a large percentage of breakage of elements in the peripheral region of the core; and breakage of filler blocks, filler strips and tiles. The greatest damage to the test assembly occurred in the core region, centered around Cluster 5F5. It was theorized and later substantiated during post-operative examination that pieces of filler strips and/or filler blocks fell from the core periphery and became lodged between the core support plate and the cluster plate surfaces. As discussed and pictured in the cluster plate examination section, several cluster plates were found to have plugged holes. The material plugging these holes was analyzed and found to be carbonaceous. These pieces apparently blocked the coolant flow to a sufficient degree to produce overheating, resulting in severe corrosion to the fueled elements, center elements and support blocks in this area. (auth)

4750 (RN-0560-10-28) INFORMAL MONTHLY PROGRESS LETTER NO. 28 COVERING PERIOD OF OCTOBER 1963. (Aerojet-General Corp., Azusa, Calif. (USA)). 1963. 174p. Dep. NTIS $11.75.
Declassified 29 Sep 1975.
The final revised design package of ETS-1 Instrumentation and Controls was received by REON from EG&G for review and approval. Approval of this package was recommended. A presentation was made by REON to SNPO covering preliminary design of the NERVA Exhaust System. Recommendations were made that this package be transmitted to AETRON, for final design work. SNPO concurred in this recommendation. The NRX-A1 reactor assembly and instrumentation was nearly completed preparatory to shipping, while the NRX-A1 simulated shield was completed and readied for shipment. Overall WANEF systems tests for Proof Assembly, Critical, were completed with the exception of the final scram time measurements. Clustering for the plugged-channel cold-flow assembly was started; orificing of 90% of the elements was completed. (auth)

4751 (RN-0560-10-30) INFORMAL MONTHLY PROGRESS LETTER NO. 30 TO AEC-NASA SPACE NUCLEAR PROPULSION OFFICE DECEMBER 1963. (Aerojet-General Corp., Azusa, Calif. (USA)). 1963. Contract SNP-1. 124p. Dep. NTIS $6.50.
Declassified 29 Sep 1975.
The NRX-A-1 pressure vessel S/N 000004, propellant feed line S/N 000001, and the pressure vessel instrumentation were acceptance tested at LRP and delivered to NRDS. The inspection and checkout of the NRX-A1 reactor proceeded. Substantial progress was made in readying the site for the NRX-A1 test. The NRX-A1 test specification was approved. Design review of the NRX-A2 non-nuclear engine assembly was completed. The aluminum pressure vessel S/N 0000002 was returned to the vendor for modifications, following which it will be hydrotested for requalification. This vessel is presently scheduled for use in the NRX-A2 test series. The core vibration-series-build reactor successfully withstood the torsional vibratory environment specified and, after examination, was re-assembled for further testing. All control drums for the pre-assembly experiment (PAX) reactor were fabricated. The design of the flexible critical experiment facility (FCX) was completed. The NRX-B core cage reactor mechanical design in which the core is divided into small clusters of fuel elements supported within the cells of the core structure was evaluated. The analytical effort to determine the most practical and feasible method of upgrading ETS-1 NES to a full pumping system, using steam as the pumping fluid, has been completed, and it has been determined that the primary ejector exit area must be increased. Hardware is being fabricated and tests will be conducted to determine the modified system performance. The preliminary design of the ETS-1 prototype duct was reviewed to determine structural adequacy. No major structural deficiencies were found. Fabrication of the steam generator system for ETS-1 is continuing. Modifications to the process water system were completed. (LTN)

4752 (RN-0560-10-31) INFORMAL PROGRESS LETTER NO. 31 TO AEC-NASA SPACE NUCLEAR PROPULSION OFFICE, JANUARY, FEBRUARY, AND MARCH 1964. (Aerojet-General Corp., Azusa, Calif. (USA)). 1964. Contract SNP-1. 202p. Dep. NTIS $8.75.
Declassified 24 Sep 1975.
Program redirection involved the deletion of the program goal of immediate development of a flight engine, with the substitution of the requirements for feasibility demonstration of an experimental engine system. Program priorities to provide the best opportunity to meet this new goal were established. These priorities emphasize development of the reactor, activation of engine test facilities, and non-nuclear hardware development, in that order. In the area of nuclear reactor experimentation, parts were delivered to the Nevada Test Site for the NRX-A1 experiment. The NRX-A1 was assembled and a series of cold-flow tests run. The results of initial tests were satisfactory, and tests were continued. Cold-flow tests by LASL of the Kiwi-B4D were run at the Nevada Test Site. Based on the successful cold-flow tests of the NRX-A1, planning was completed for the NRX-A2 hot-test experiment, and test planning for NRX-A3 is progressing on schedule. Work on the finalization of ETS-1 I&C criteria showed satisfactory progress. Model testing for the Nuclear Exhaust System was carried out, and the results were incorporated into the final design of the duct. Work on the turbopump assembly was realigned to eliminate the development of the Mark IV TPA in favor of some development effort applied to increase the capability of the Mark III, Mod 3 TPA. Development work continued on the nozzle. This effort took the form of continued fabrication development of the aluminum cast jacket nozzle and the completion of a U-tube nozzle design. (auth)

4753 (RN-0560-10-32) INFORMAL PROGRESS LETTER NO. 32 TO AEC-NASA SPACE NUCLEAR PROPULSION OFFICE. Period Covered: April, May, June 1964. (Aerojet-General Corp., Azusa, Calif. (USA)). 1964. 96p. Dep. NTIS $6.00.
Declassified 24 Sep 1975.
A preliminary design review presentation of the XE-Engine made to SNPO included a brief description of all engine components and a design and development status report. The major review effort centered on overall engine system layout, remote

handling concepts, engine system analysis, and a review of design status of the test stand adapter, external engine shield, and engine thrust structures. TPA low-speed testing was initiated in the H-6 facility at LRP with cold-gas drive to turbine. Fabrication of two nozzles of U-tube configuration has been completed. Four hot firing tests have been conducted on U-tube nozzles and five tests were made on a cast aluminum Hybrid nozzle. The NERVA Support Equipment Technical Description Handbook was completed and distributed. Radiation testing was conducted on pressure transducers, resistance temperature transducers, strain gages, and high-temperature thermocouples in GTR-12A and 13 at Fort Worth, Texas. All test procedures were completed for CFDTS NRX-A2 hardware. Environmental testing was started on NRX-A2 CFDTS instrumentation and hardware. Operation manuals and instructions, component drawings, and mounting sketches for NRX-A2 instrumentation support equipment were completed and released. The 1/4 scale NES duct ejector system was fabricated and installed, and operated satisfactorily during checkout testing. The feasibility of uprating the ETS-1 NES to have full altitude simulation capability with steam as the secondary ejector fluid was confirmed. The ETS-1 NES duct final design has been completed, reviewed and approved by REON and SNPO-C, and bidders have been solicited. Fabrication of the first steam generator module is complete and it is undergoing acceptance testing at Thiokol (RMD) in New Jersey. (auth)

4754 (RN-0560-10-33) INFORMAL PROGRESS LETTER NO. 33 TO AEC-NASA SPACE NUCLEAR PROPULSION OFFICE, JULY, AUGUST, SEPTEMBER 1964. (Aerojet-General Corp., Azusa, Calif. (USA)). 1964. 257p. Dep. NTIS $10.00.
Declassified 24 Sep 1975.
Progress continued on the NRX-A1, -A2, -A3, -A4-EST and XE-PRIME reactors in design, fabrication, test plans, etc. Reactor component design and testing and test facility modifications are discussed. Remote handling equipment is being developed. Instrumentation development and testing (including radiation effects testing) is summarized. (LTN)

4755 (RN-A-005(Vol.1)) NERVA PROGRAM. Summary Report CY' 65 for Period Ending 30 September 1965. (Aerojet-General Corp., Sacramento, Calif. (USA)). 1965. 285p. Dep. NTIS $10.25.
Declassified 22 Sep 1975.
Major steps taken during CY'65 in the development of the NERVA Nuclear Rocket Engine were: The successful power testing of the NRX-A3 reactor at NRDS in April and May 1965; the engine boot-strap startup design data acquired from the testing of the Cold Flow Development Test System, CFDTS, at the Sacramento H-Area; the qualification, delivery, and assembly of all component hardware for the Engine System Test in Test Cell "A" (NRX/EST) at NRDS; the demonstration, by test, of the hot-gas port and line as satisfactory for NRX/EST conditions; the development of the turbopump to the extent that it endured in excess of 20 minutes operation at the NRX/EST maximum power conditions; the tentative definition of the NRX-A5, NRX-A6, and XE-1 reactor configuration; the upgrading of overall engine duration targets from 10 to 60 minutes; and considerable progress in the analytical prediction of NRX/EST and engine behavior, and in XE-1 engine design supporting technology, non-nuclear component development, and hardware production for future end item assemblies. (auth)

4756 (RN-A-0001(Vol.3)) NERVA SUMMARY REPORT FOR CONTRACT YEAR 1963. (Aerojet-General Corp., Azusa, Calif. (USA)). Dec 1963. 298p. Dep. NTIS $10.25.
Declassified 23 Sep 1975.
The technical management and integration of the nuclear subsystem into the NERVA engine is described, through the NRX series of reactor tests and the development efforts associated with producing the nuclear subsystem. Program planning was a continuous function, reflected in program direction and scheduling, and in detail as technical developments occurred or were discovered to be different than expected or planned. Input to this program planning, which came from many sources, was reflected in program recommendations to SNPO and in program directions to the nuclear subcontractor. All of these efforts were carried out to integrate the nuclear subsystem into an eventual flight-rated nuclear engine. An increasingly important part of the nuclear subsystem development program is the component test program. Differential testing, prior to integral testing in a hot reactor system test, has been shown to be necessary to improve the probability of successful reactor testing. This program has extremely important implications to the engine system, since experimental results affect the kinetic, and thermal, and hydraulic behavior of the whole engine system. It is, at the same time, a very expensive program both in money and skilled manpower. The planning and performance were therefore carefully reviewed and analyzed to insure that maximum benefit to the engine system would be derived. Participation in extended formal program review meetings, combined with reviews and approval recommendations of test plans, schedules, and equipment for each of the tests provided close control and integration of this very important program; and control and integration was achieved as economically as consistent with engine development schedules. (auth)

4757 (RN-A-0001(Vol.4)) NERVA SUMMARY REPORT FOR CONTRACT YEAR 1963. (Aerojet-General Corp., Azusa, Calif. (USA)). Dec 1963. 256p. Dep. NTIS $10.00.
Declassified 23 Sep 1975.
Support equipment, remote handling equipment, transport equipment, checkout and testing equipment, test facilities, radioactive materials storage, radiation effects facility, exhaust systems, etc., efforts in support of the NERVA project are described. Reliability, quality assurance, safety and training efforts are included. (LTN)

4758 (RN-DR-0042) PRESENTATION ON THE GROWTH POTENTIAL OF THE S/N 9 NERVA NOZZLE. (Aerojet-General Corp., Sacramento, Calif. (USA)). Oct 1964. 36p. Dep. NTIS $5.00.
Declassified 18 Sep 1975.

4759 (RN-DR-0075) SNPO XE REVIEW. (Aerojet-General Corp., Sacramento, Calif. (USA)). Mar 1966. 262p. Dep. NTIS $10.00.
Declassified 22 Sep 1975.
Reproductions of the visual aids employed during the SNPO XE Review Meeting held at the Aerojet-General Corporation, Sacramento, California on 22 and 23 March 1966 have been documented. (auth)

4760 (RN-NC-0007) SNRE SMALL NUCLEAR ROCKET ENGINE FOR UNMANNED SPACE PROBE MISSION. Flagg, A. H. (Aerojet-General Corp., Sacramento, Calif. (USA)). Aug 1966. 99p. Dep. NTIS $6.00.
Declassified 18 Sep 1975.
A Topping Cycle-Small Nuclear Rocket Engine, SNRE, of 10,000 lb thrust based on a zirconium hydride moderated 200 MW reactor design concept and present technology for non-nuclear engine components are described. Emphasis is given to the engine description, performance and operation, to the turbopump, and to the nozzle design features. An alternate, hot bleed cycle SNRE design with additional turbopump and nozzle development is discussed briefly. A potential development program covering a period of five years from start to initial operational capability is suggested with reference to engine system tests, turbopump and nozzle schedules and an indication of possible schedules for stage ground and flight tests. (auth)

4761 (RN-PA-0001) CLUSTERING OF NUCLEAR ENGINES. Houghton, W. J. (Aerojet-General Corp., Azusa, Calif. (USA)). May 1964. 34p. Dep. NTIS $5.00.
Declassified 19 Sep 1975.
Clustering has come to be of interest in nuclear engines for the same reasons that it was adopted for chemical engines. In particular, it is thought that a higher thrust power plant can be developed for less expense, and that overall reliability might be increased. This investigation, therefore, includes malfunction considerations and preliminary thoughts on reliability. One feature involved in the clustering of nuclear engines that is different from chemical engines is the possibility of interactions between the reactors by means of the exchange of neutrons. This will affect the reactivity and power distribution of each reactor, and the determination of tolerable limits on these effects provides one of the bases for choosing reactor separation distance and side shielding design. This interaction is also considered when designing for engine-out capability, since nuclear reactors cannot easily be completely shut down in a neutron environment. Another difference from chemical engines is the high intensity radiation field surrounding the nuclear engines. Design of the stage tank bottom is greatly influenced by this field. Nuclear radiation shields are used to protect components. The weight penalty for minimum shielding has been estimated. A variety of mechanical modifications are necessary when adapting a single nuclear engine so that it can become part of a cluster. New thrust structures must be designed, and the need for heat shields must be considered. A clustered engine concept is presented, with specifications and operating characteristics. A comparison is made between the clustered engines and a single nuclear engine with thrust about equal to that of the cluster. (auth)

4762 (RN-PA-0018(Bk.2)) SYSTEMS-ENGINEERING AND TRADE-STUDY-REPORTS MEETING. Period Covering 22-23 April 1969. (Aerojet-General Corp., Sacramento, Calif. (USA)). Apr 1969. Contract SNP-1. 10p. Dep. NTIS $4.50.

Declassified 19 Sep 1975.

The differences between measured and predicted values, including uncertainties, of a few parameters in a few reactors are listed and possible methods of reducing the errors and uncertainties are given. (LTN)

4763 (RN-PA-0024(Vol.2)) MATERIAL PRESENTED TO SNPO IN SHIELDING TRADE STUDY REVIEW. Capo, M. A. (Aerojet-General Corp., Sacramento, Calif. (USA)). 23 Oct 1969. Contract SNP-1. 169p. Dep. NTIS $8.50.

4764 (RN-A-0038) QUARTERLY PROGRESS REPORT NO. 38 FOR SECOND QUARTER, CY 1966 COVERING THE PERIOD OF JANUARY, FEBRUARY, AND MARCH 1966. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jun 1966. 386p. Dep. NTIS $11.75.

Declassified 8 Oct 1975.

The objectives of the NRX/EST engine program were achieved in a series of tests conducted at NRDS. The first start of a nuclear rocket system to power with an engine turbopump was achieved. The bootstrap-to-intermediate power run was successful on the first attempt and actual engine performance closely followed predictions. A second bootstrap test was conducted on the same day with a cold reflector, to simulate restart in space conditions. Again, the characteristics of the startup followed the predicted performance. This test verified the feasibility of restarting the engine in space without an external energy source. The NRX/EST, as the first breadboard nuclear rocket engine, was used to evaluate performance over a wide range of operating conditions by mapping lines of constant temperature at 2500, 3400, and 4000°R. Turbopump Assembly (TPA) work continues to be ahead of schedule. Endurance testing was completed on three successive turbopumps. Nozzle development, fabrication and testing continued. Modification and checkout of the modified preliminary analog and digital NERVA engine models was completed. Parametric studies of the NERVA turbopump were completed and the conceptual design is continuing as directed by the NDC-128 design criteria. Nozzle contour optimization studies have been completed. Preliminary studies of the NERVA pressure vessel design, materials, and fabrication procedures was started. Inconel 718 is recommended, with aluminum alloy 7039 as a backup. A materials program for Inconel 718 is being prepared and preliminary investigation of fabrication procedures and costs is underway. A comparison of XE and NERVA control requirements was started and coordination with WANL regarding reactor control requirements was also started. Nuclear analyses were primarily related to nuclear heat generation and the neutron-induced activity of NERVA engine components. (auth)

4765 (RN-Q-0040) QUARTERLY PROGRESS REPORT NO. 40 FOR FIRST QUARTER, CY 1967, COVERING THE PERIOD OF OCTOBER, NOVEMBER, AND DECEMBER 1966. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jan 1967. Contract SNP-1. 259p. Dep. NTIS $10.00.

Declassified 22 Sep 1975.

Progress in NRX-A6 and XE-PRIME Reactors is reported, especially with respect to fuel elements, values, nozzles, pressure vessels and mathematical models. Test facility modifications and checkout testing are also reported. (LTN)

4766 (RN-S-0109) EVALUATION TESTING OF BENDIX NDC-2 SERIES TPCV ACTUATORS. (Aerojet-General Corp., Sacramento, Calif. (USA)). Sep 1964. 57p. Dep. NTIS $5.50.

Declassified 22 Sep 1975.

The test results of the Turbine Power Control Valve Actuator designed by the Bendix Corporation, Series NTC, are presented. The high temperature and thermal shock performance of the Bendix NTC-2 Actuator is very good. For cryogenic endurance and vibration the NTD-1 design will have significant improvements: The modified dynamic seal, and the side by side placement of the servo-valve-torque-motor assembly and the gear-motor-potentiometer assembly. This is a far more rigid mounting arrangement than previously used. The operating response and associated performance are quite satisfactory. The NTC-2 Actuators exhibit very small load variation and gas temperature sensitivity. The problems remaining with the NTC-2 actuators have been considered in NTD-1 design and are not expected to be present in that actuator configuration. As the NTD-1 actuator is the next logical step in the development of TPCV Actuators, it is strongly recommended that actuators of this design be constructed and tested. No radiation tests have been made on NTC-2 actuators. However, extensive testing was accomplished with NTB series actuators. Although the NTB radiation tests were successful, a short radiation test program, as outlined, should be conducted with an NTC-2 actuator. (auth)

4767 (RN-S-0117) PRESIDENT'S SCIENTIFIC ADVISORY COMMITTEE. (Aerojet-General Corp., Sacramento, Calif. (USA)). 24 Jul 1964. 201p. Dep. NTIS $8.75.

Declassified 22 Sep 1975.

Material presented to the President's Scientific Advisory Committee has been documented. It includes a good description of the developments and test results to date and also photographs of manufacturing and test facilities. (LTN)

4768 (RN-S-0123(Vol.1)) DESIGN ANALYSIS, MK 4 MOD 2 TURBOPUMP. (Aerojet-General Corp., Sacramento, Calif. (USA)). Aug 1965. 300p. Dep. NTIS $10.25.

Declassified 22 Sep 1975.

The design of the Mark IV, Mod 2 turbopump was accomplished as a backup to the MK III, Mod 3 configuration. It contains certain pump improvements and contingency features. The Mark IV TPA design, from the standpoint of fluid dynamics, is essentially a modified Mark III, Mod 3 design, for which design data on pumping performance were presented in REON Report RN-TM-0211. The pump configuration includes a single-stage, radial-exit flow impeller, a constant velocity volute, and a vaned diffuser housing. (auth)

4769 (RN-S-0123(Vol. 7)) MK 4 MOD 2 TURBOPUMP. Volume 7. Assembly Features and Miscellaneous Considerations. (Aerojet-General Corp., Sacramento, Calif. (USA)). Dec 1965. 90p. Dep. NTIS $6.00.

Declassified 30 Sep 1975.

The overall considerations are presented in the design of the Mark IV Mod 2 turbopump, including assembly procedures, general handling requirements, general sealing requirements, and miscellaneous analyses not otherwise presented. (auth)

4770 (RN-S-0133) PRELIMINARY REPORT ON THE NERVA RADIATION ENVIRONMENT. (Aerojet-General Corp., Sacramento, Calif. (USA)). Mar 1965. 80p. Dep. NTIS $6.00.

Declassified 19 Sep 1975.

A preliminary analysis of the NERVA radiation environment for a flight configuration has been completed. Neutron and gamma ray dose rates during both full power operation and following shutdown were investigated and the results are given in the form of two-dimensional contour maps and tables of environment data for all components of the engine. The preliminary nature of these results requires the use of position dependent uncertainty factors which vary from a low of ±50% to a high of about a factor of four. The factor of four uncertainty exists for those components located in the $\alpha = 0°$ direction where the analysis was inadequate for treatment of radiation scattering, component self-shielding, secondary gamma ray sources, and neutron thermalization in LH_2 containing components. Follow-on work in the above areas will be undertaken to reduce the uncertainty in defining the radiation environment for the NERVA engine components. (auth)

4771 (RN-S-0150) STATUS REPORT ON ANALYSIS OF THE COLD FLOW DEVELOPMENT TEST SYSTEM. (Aerojet-General Corp., Sacramento, Calif. (USA)). Sep 1964. Contract SNP-1. 64p. Dep. NTIS $5.50.

Declassified 19 Sep 1975.

The purpose of the analytical investigation of the cold flow development test system (CFDTS) is to provide information on how the stored energy of the components will integrate into the bootstrapping of an engine system. The objectives of the CFDTS are to verify the control functions and start-up sequence of operations previously determined by transient analysis with a mathematical model in order to develop a reliable start-up procedure for the engine system and to evaluate flow characteristics of an unfueled nuclear engine system to determine chilldown time, temperatures, flow rates, and pressure drop data throughout the system. Mathematical models have been developed representing the transient behavior of the system. These models have been programmed on both the analog and digital computers in order to obtain performance data on the system. Using these programs, the following areas were investigated: scheduling of TPCV, tank pressure, effects of back pressure, effects of dry versus wet pump during start, methods of improving system performance, effects of chilldown, investigation of diluent valve position on engine start-up, and substitution of different nozzles. (auth)

4772 (RN-S-0173(Vol.3)) NERVA TECHNICAL REVIEW MEETING, AEROJET-GENERAL CORPORATION, SACRAMENTO, CALIFORNIA, NOVEMBER 17-19, 1964. (Aerojet-General Corp., Sacramento, Calif. (USA)). Dec 1964. Contract SNP-1. 248p. Dep. NTIS $9.00.

Declassified 19 Sep 1975.

Volume 3 of the NERVA Technical Review Meeting includes discussions of engine and test stand controls systems, controls analysis methods, actuators and methods of testing them, ground support and remote handling equipment, the nuclear exhaust system, the test stand and test cell "A" facilities, and the maintenance buildings (E-MAD and R-MAD). (LTN)

4773 (RN-S-0309) NRX/EST DATA ANALYSIS. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jul 1966. 352p. Dep. NTIS $11.50.

Declassified 19 Sep 1975.

The NRX/EST test series was the first complete nuclear rocket engine system with major components connected in the flight functional relationship. The test results: Verified experimentally the feasibility of the hot bleed cycle, nuclear engine system including the ability to startup (bootstrap) smoothly and satisfactorily in a large number of different startup modes; demonstrated the breadth of the engine operating region and the smoothness with which the engine could perform at both design and off-design conditions; demonstrated the ability of the engine as a whole, consisting of the reactor and the various non-nuclear components to operate for extended durations (including 29.2 minutes of operation at power levels of 1000 mw or greater and a total operating time of 116.3 minutes); and obtained a large amount of systems, controls, and component data to permit a firmer basis of understanding and verification of the analytical tools to support the design of the X-engine and the larger NERVA engine. Analyses of the overall operation of the NRX/EST breadboard engine and of various non-nuclear aspects and components are presented. (auth)

4774 (RN-S-0388) NPSP EVALUATION. (Aerojet-General Corp., Sacramento, Calif. (USA)). Mar 1967. 120p. Dep. NTIS $6.50.

Declassified 29 Sep 1975.

A highly technical presentation on the estimates of the relative merits of zero and positive net pump suction pressure (NPSP) on the overall NERVA vehicle performance has been documented. The calculations are based on a proposed 1982 mission and evaluated on the basis of savings in weight, but alternative methods of estimating the merit are given. The calculations involve the estimation of the effects of radiation heating during the mission on tank pressure and pump performance. Experimental results which support the calculations are quoted. (LTN)

4775 (RN-S-0528(Vol.1)) 75K NERVA ENGINE SYSTEM ANALYSIS S-1 DATA ITEM. (Aerojet-General Corp., Sacramento, Calif. (USA)). Aug 1969. 241p. Dep. NTIS $9.00.

Declassified 10 Sep 1973.

Current component information used for systems analysis is provided and is divided into five main sections: Objectives and general and detailed information concerning components and operation of the NERVA engine; detailed NERVA engine model information for input into computer programs. Each subsection is divided into the following subsections (component name; description; applicable drawings; component data; general mathematical equations; calculations; and references); general and detailed information concerning the test facility and engine instrumentation; an input listing of the NERVA Engine Transient Analysis Program (D31201); and Flight Engine Program (FEP) constants. The equations used were developed by Westinghouse (reactor) and Aerojet (engine system) for the common analog model and may be found in E-1 Common Analog Model, AGC Report RN-S-0469, July 1968. (auth)

4776 (RN-TM-0310) LARGE DIAMETER REACTOR ENGINE ANALYSIS PROGRAM. Hart, G. D. (Aerojet-General Corp., Sacramento, Calif. (USA)). 22 Dec 1965. 30p. Dep. NTIS $5.00.

Declassified 22 Sep 1975.

A brief discussion of the digital computer program 12013 is presented, with cycle points from a sample steady state run. The required input format is specified, followed by a listing and definition of the input for the full power steady state case. To date this program has only been used for steady state analysis of a 5000 MW engine; it also has the capabilities of startup and shutdown analyses with minor modifications in the input. Program 12015, a similar program minus the TPA and hot bleed port, has been used for cooldown analyses. (auth)

4777 (RN-TM-0365) RADIATION ANALYSIS FOR NON-NUCLEAR COMPONENTS OF THE NERVA DEVELOPMENT ENGINE NRX-A6 REACTOR TEST. (Aerojet-General Corp., Sacramento, Calif. (USA)). 1 Feb 1967. 77p. Dep. NTIS $6.00.

Declassified 18 Sep 1975.

Extensive radiation analyses have been completed to determine the radiation heating and neutron and gamma radiation intensities in the non-nuclear portions of the NRX-A6 NERVA development engine reactor test. The results of these analyses are presented along with a discussion of the calculational methods employed and the analytical models and radiation sources. One of the principal differences between NRX-A6 and the previous NRX reactor tests is the fact that it will be tested in the Phoebus-1B 360° cylindrical enclosure shield at Test Cell C. Some comparisons are made with previous NRX test articles and configurations; and observations are made regarding areas of differences in radiation levels and their probable causes. A number of locations are analyzed in order to obtain pre-test predicted values to be compared with dosimetry results which will become available subsequent to the performance of the NRX-A6 test. Such comparisons are invaluable in assessing the accuracy of calculational techniques with which radiation levels can be calculated for this and future tests with varying degrees of complexity. (auth)

4778 (RP-MR-0013) PHOEBUS-2 MONTHLY PROGRESS REPORT FOR THE PERIOD OF 1 SEPTEMBER–30 SEPTEMBER 1966. (Aerojet-General Corp., Sacramento, Calif. (USA)). Oct 1966. 38p. Dep. NTIS $5.00.

Declassified 30 Sep 1975.

Nozzle flow is considered for three different regimes: Full nozzle flow, supercritical coolant, film cooling; separated nozzle flow, supercritical coolant, film cooling; and separated nozzle flow, subcritical coolant, film cooling. The coolant pressure drop and enthalpy rise are calculated using closed-form equations. Other nozzle design, fabrication, brazing and testing work is summarized. (LTN)

4779 (RP-TM-0007) PHOEBUS-2. Hydrogen Disposal Burn Pond. (Aerojet-General Corp., Sacramento, Calif. (USA)). Oct 1966. 87p. Dep. NTIS $6.00.

The Phoebus-2 Hydrogen Disposal Pond (Burn Pond) Report includes a survey of available hydrogen disposal methods, a discussion of problem areas in using a hydrogen disposal pond system, the hydrogen disposal method to be used by Aerojet-General, and the testing which led to the final hydrogen disposal pond design. (auth)

4780 (RP-MR-0014) PHOEBUS-2 MONTHLY PROGRESS REPORT, 1 OCTOBER–31 OCTOBER 1966. (Aerojet-General Corp., Sacramento, Calif. (USA)). Nov 1966. 119p. Dep. NTIS $6.50.

Declassified 30 Sep 1975.

Progress in the design, fabrication and testing of nozzles for the PHOEBUS-2 reactor is reported, including extensive stress analyses and determination of the tensile properties of Hastelloy X. (LTN)

4781 (RP-TM-0001) FIGURES PRESENTED IN TECHNICAL STATUS REPORT ON PHOEBUS-2 NOZZLE PROGRAM, 23–24 SEPTEMBER 1965. (Aerojet-General Corp., Sacramento, Calif. (USA)). 1965. 161p. Dep. NTIS $7.75.

Declassified 16 Sep 1975.

Material presented in a Technical Status Report on PHOEBUS-2 Nozzle Development has been documented. A part of the work reported involves the forging and metallurgy of large Hastelloy X ingots. Brazing and welding developments are reported. Heat transfer and pressure drop measurements are reported. (LTN)

4782 (TCD-9650-007) NERVA HOT BLEED PORT AND COOLED ELBOW ANALYSIS. Luvisi, F. P. (Aerojet-General Corp., Sacramento, Calif. (USA)). 15 Jul 1963. 29p. Dep. NTIS $5.00.

Declassified 22 Sep 1975.

In the NERVA rocket engine, a turbine driven by partially cooled hydrogen from the nozzle powers the propellant pump. The gas is withdrawn from the nozzle through a bleed port and attached elbow section, which is jacketed and cooled with liquid hydrogen. The coolant flows from the elbow section inlet to the bleed port entrance, and after flowing between the bleed port and bleed port insert, is injected into the gas stream through a series of orifices. As a result the hot gas temperature is reduced from 4090°R to 1800°R. In the analysis the gas entering the bleed port from the nozzle is referred to as the hot gas flow. The hot gases plus the injected coolant are referred to as mixed flow. The analysis was performed for mixed flow rates of 6.0 and 4.0 lb/sec and determined the following: Hot gas and coolant flow rates to achieve a mixed flow temperature of 1800°R; temperatures and heat fluxes along the cooled elbow; elbow coolant pressure drop and required bleed port orifice area; clearance between the bleed port and bleed port insert; and LO_2/LH_2 simulation conditions. (auth)

4783 (TCD-9660-003) KIWI-B FINAL TEST REPORT. Wright, R. B. (Aerojet-General Corp., Sacramento, Calif. (USA)). 31 Jan 1964. 39p. Dep. NTIS $5.00.

Declassified 23 Sep 1975.

A simulation firing was performed on Kiwi-B Nozzle S/N 001K. During a very smooth start transient without abnormal pressure surges or signs of instability, the aluminum jacket failed at approximately 3.5 seconds. Since there were no pressure spikes, signs of instability or rapid accelerations on the oscillograph records, it has been concluded that jacket failure occurred as a result of thermal shock combined with very low ductility of

the aluminum jacket. Metallurgical analysis reports list elongation of cast aluminum samples taken from the failed nozzle to be only 1.5 to 2.5% at room temperature and 1.0 to 2.0% at −320°F. Stress analysis shows that this low ductility combined with thermal stresses produced by flowing liquid hydrogen through the nozzle tubes could produce the type of failure which occurred. Hardware damage was limited to the nozzle and propellant inlet line with no damage to the injector or nozzle to injector adapter. Test stand damage was limited primarily to burned instrumentation cables. (auth)

4784 (TID/SNA−1817) EFFECTS OF RADIATION ON BEARING CAGE MATERIALS AND RETAINERS IN A LIQUID-HYDROGEN ENVIRONMENT. Weleff, W.; Accinelli, J. B. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jun 1967. 35p. Dep. NTIS $5.00.

Radiation effects tests were conducted on bearing cages, bearing cage materials and full scale bearings with dose levels ranging from (1-100)10^9 ergs/gm (C) at liquid hydrogen temperatures. Most materials were degraded in tensile and flexural strength (sometimes after an initial increase at the lower dose levels), but the properties of superpolymer SP-3 were unaffected by test temperature or by radiation levels up to 3×10^{10} ergs/gm (C). In another test ball bearings were extensively damaged by radiation of 1×10^9 ergs/gm (C) while in liquid hydrogen for one hour, whereas roller bearings subjected to the same dose and conditions survived in satisfactory condition. (LTN)

4785 (TID/SNA-1828) TRANSMITTAL OF SLIDE COPIES. Kirk, W. L. (Los Alamos Scientific Lab., N. Mex. (USA)). 2 Mar 1965. 154p. Dep. NTIS $7.75.

Declassified 29 Sep 1975.

Material shown at a Los Alamos PHOEBUS reactor presentation on February 18, 1965 has been documented. Considerable data on design, neutronics, temperature distribution and expected performance are given. (LTN)

4786 (TID/SNA−1843) LASL PHOEBUS PRESENTATION. Phoebus-2 Neutronics. Orndoff, J. D. (Aerojet-General Corp., Sacramento, Calif. (USA)). 18 Feb 1965. 174p. Dep. NTIS $7.75.

Declassified 29 Sep 1975.

4787 (TID/SNA-2259) DELIVERY OF A LIQUID-HYDROGEN PUMP SYSTEM. (Aerojet-General Corp., Azusa, Calif. (USA)). May 1960. 32p. Dep. NTIS $5.00.

Declassified 30 Sep 1975.

In response to University of California Purchase Request IU-1523 a proposal is submitted for the delivery of an integrated, single-stage, gas-turbine-driven, liquid-hydrogen pumping unit, for incorporation in the liquid-hydrogen feed system shown schematically. When operated with a suction pressure of 40 psig, this unit will deliver 70 lb/sec at a discharge pressure of 1100 psig. The normal operating range will be from 7 to 70 lb/sec. A mounting stand and auxiliary equipment necessary for purge, lubrication, control, and monitoring overall operation will be furnished with the pumping unit. Field engineering services will also be provided to cover original installation and recommended preliminary operational testing. (auth)

4788 (TID/SNA-2264) DRAGON MEMORANDA: EP-III, IIIA, NRX-A6 TEST SERIES. (Aerojet-General Corp., Azusa, Calif. (USA)). 20 Dec 1967. 287p. Dep. NTIS $10.25.

Declassified 24 Sep 1975.

Memoranda on runs EP-III ABORT and EP-IIIA of the NRX-A6 Test Series have been bound together. The first run was terminated by a spurious emergency shutdown approximately one minute after reaching 2000° R hold of the start-up profile. Investigation showed that the minimum drum position input to the shutdown chain tripped in response to a noise spike induced in the drum position averaging amplifier by the mode switching relay (further details are given). Run EP-IIIA was a successful full power test for a little more than one hour. Reactivity loss was less than expected for a run of this duration. (LTN)

4789 (TID/SNA-2279) MINUTES OF THE FIFTH MEETING OF THE ROVER FLIGHT SAFETY PANEL, CAPE CANAVERAL, FLORIDA, APRIL 18−19, 1962. (Aerojet-General Corp., Sacramento, Calif. (USA)). 1962. 38p. Dep. NTIS $5.00.

Declassified 24 Sep 1975.

Launch facilities at Cape Canaveral are described. Very preliminary launch plans for the Reactor In Flight Test (RIFT) stages were discussed, including facilities required, checkout problems, criticality problems, destruct systems, beryllium toxicity problems, leaching programs (in seawater), etc. Chemical rocket accidents at Cape Canaveral are listed and described briefly. (LTN)

4790 (TID/SNA-3034) COMPILATION OF LASL N-2 DOCUMENTS AS OF OCTOBER 1963. Volume II. (Aerojet-General Corp., Azusa, Calif. (USA)). Oct 1963. 285p. Dep. NTIS $10.25.

Declassified 19 Sep 1975.

Fifteen reports dealing with KIWI and ROVER reactors (neutronics and progress reports) from the LASL N-2 Division have been compiled. A report on the reactivity and material loss which occurred during the testing of KIWI-4 is included. (LTN)

4791 (TID/SNA-3035) COMPARISON OF THE FULL FLOW AND HOT BLEED ENGINES FOR NERVA APPLICATION. Book 2. (Aerojet-General Corp., Sacramento, Calif. (USA)). May 1969. 54p. Dep. NTIS $5.50.

Declassified 18 Sep 1975.

In changing from the Hot-Bleed Engine (HBE) to the Full Flow Engine (FFE), the NSS is affected in two general ways. Pressure levels and component ΔP's are altered in various areas of the NSS, and provisions must be incorporated for discharge of the flow from the reflector outlet plenum to the turbine and for accepting the returned turbine discharge flow. Changes may be required in testing Full Flow Engines in test cell "C". There may be small differences in reliability or in the development effort required. It is concluded that the Nuclear Subsystem of the Full Flow Engine is technically feasible. (auth)

4792 (TID/SNA-3046) ANALYTICAL PROCEDURE FOR THE STRUCTURAL ANALYSIS OF THE REACTOR CORE BASE ADAPTER. Clark, R.; Fernandez, D. (Aerojet-General Corp., Azusa, Calif. (USA)). [nd]. 41p. Dep. NTIS $5.00.

Declassified 8 Oct 1975.

A procedure is established for the structural analysis of perforated circular plates which are utilized in supporting the reactor core structure in some reactor designs. The method consists of replacing the perforated plate by an imaginary homogeneous plate which has modified material mechanical properties, E* (modulus of elasticity) and u* (Poisson's ratio). The stresses developed in the ligaments between the perforations in the actual plate, are then evaluated readily in terms of the stresses calculated for the homogeneous plate. In the case of the core-base-adapter, this procedure will be further modified to account for curvature effects. In order to verify the validity of the structural analysis, a lucite core base-adapter which exhibits mechanical properties similar to the actual reactor core base adapter material, was subjected to a structural load test which simulated actual environmental conditions. Strain and deflection data was obtained from the test that compared very well with theoretical values. (auth)

4793 (TID/SNA-3048) KIWI B-4A COLD FLOW. Photo Index. (Aerojet-General Corp., Sacramento, Calif. (USA)). 1963. 44p. Dep. NTIS $5.00.

Declassified 24 Sep 1975.

This document consists entirely of photographs of the assembly of the KIWI-B4A-cold flow reactor emphasizing the instrumentation of the unit. (LTN)

4794 (TID/SNA−3054) DEVELOPMENT OF A NUCLEAR ROCKET ENGINE. Volume V. Related Experience and Key Personnel. (Aerojet-General Corp., Azusa, Calif. (USA)). Apr 1961. 315p. Dep. NTIS $10.75.

Declassified 29 Sep 1975.

Aerojet-General, because of its long involvement in advancing all phases of the art of rocket propulsion, has the experience, the personnel, and the facilities needed for undertaking a program like the one proposed. Information concerning the company's experience with research on and development of rocket propulsion systems and related equipment is provided. In addition, information is provided regarding key personnel who will be assigned to the development team should Aerojet be the successful bidder for this work. (auth)

4795 (TID/SNA-3058) COMPILATION OF LASL N-1 DOCUMENTS AS OF OCTOBER 1963. Volume II. (Aerojet-General Corp., Azusa, Calif. (USA)). Oct 1963. 217p. Dep. NTIS $8.75.

Declassified 23 Sep 1975.

Methods of fuel element testing and of chemical analysis used in the Research and Development Program for Pyro-Coated, Uranium Dicarbide-Loaded, Graphite Fuel Elements at LASL have been boundtogether in this document, which consists of 15 original LASL reports. (LTN)

4796 (TID/SNA-3064) NERVA PROGRAM TECHNICAL REVIEW, FEBRUARY 26, 27, AND 28, 1962. (Aerojet-General Corp., Azusa, Calif. (USA)). Feb 1962. 78p. Dep. NTIS $6.00.

Declassified 12 Nov 1975.

4797 (TID/SNA-3066) KIWI-B-4A DISASSEMBLY AND POST-MORTEM PHOTOGRAPHS. (Aerojet-General Corp., Sacramento, Calif. (USA)). [nd]. 226p. Dep. NTIS $9.00.

Declassified 8 Oct 1975.

Post-mortem photographs of KIWI-B4A, without text, are shown, emphasizing the fuel element damage which occurred during the test and the damage which the ejected fragments did to the nozzle coolant tubes. (LTN)

4798 (TID/SNA-3067) PHOEBUS-1B STATUS REVIEW: BRIEFING MATERIAL, OCTOBER 19 AND 20, 1965. (Aerojet-General Corp., Sacramento, Calif. (USA)). 1965. 156p. Dep. NTIS $7.75.

Declassified 8 Dec 1975.

4799 (TID/SNA-3076) INSTRUMENTATION AND CONTROL SYSTEM DESIGN CRITERIA. Test Cell ETS-1 NNRDC. Volume 3. Criteria Technical Data Sheets (Equipment). (Aerojet-General Corp., Sacramento, Calif. (USA)). Jan 1962. 247p. Dep. NTIS $9.00.

Design criteria are provided for the instrumentation, control, and data acquisition systems of ETS-1. Detailed technical data sheets are provided for system components. (LTN)

4800 (TID/SNA-3078) INSTRUMENTATION AND CONTROL SYSTEM CRITERIA. Test Cell ETS-1 NNRDC. Volume I. Criteria. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jan 1962. 517p. Dep. NTIS $13.75.

Design concepts, criteria, and preliminary design for the Remote Engine Control System, the Facilities Operations and Controls Systems, and the Data Acquisition System for the NNRDC Test Cell ETS-1. Included are drawings necessary to depict system and subsystem concepts and preliminary design; not included however, are hardware fabrication drawings, which are tasks of detailed design, and represent the point of departure between criteria and preliminary design, and detailed design. In addition, the integration of these systems into the complete facility is analyzed with respect to overall facility missions, objectives, and system interfaces. (auth)

4801 (TID/SNA-3080) HOT BLEED CYCLE, 75K NERVA ENGINE SYSTEM ANALYSIS. (Aerojet-General Corp., Sacramento, Calif. (USA). Nuclear Div.). Dec 1969. 244p. Dep. NTIS $9.00.

Declassified 30 Sep 1975.

Current component information used for systems analysis is provided: Objectives and general and detailed information concerning components and operation of the NERVA engine; detailed NERVA engine model information for input into computer programs (component name; description; applicable drawings; component data; general mathematical equations; calculations; and references); an input listing of the NERVA Engine Transient Analysis Program (D31201); and Flight Engine Program (FEP) constants. Equations developed by Westinghouse (reactor) and Aerojet (engine system) for the common analog model may be found in E-1 Common Analog Model, AGC Report RN-S-0469, July 1969, Revision 2. (auth)

4802 (TID/SNA-3084) REMOTE DIAGNOSTIC DISASSEMBLY PROCEDURE FOR THE NERVA MARK E-1 ENGINE TURBOPUMP ASSEMBLY. Herdan, J. G.; Snyder, J. G. (Aerojet-General Corp., Sacramento, Calif. (USA)). 30 Dec 1962. 27p. Dep. NTIS $5.00.

Declassified 24 Sep 1975.

The steps necessary to remotely disassemble an irradiated E-1 Engine Turbopump are described, and the remote-manipulator and other tools required are shown. This turbopump configuration is essentially the one to be used with the E-1 Engine. Although remote disassembly was not a design criterion for this turbopump configuration, a time advantage can be obtained by operating the E-1 Engine Turbopump in a radiation environment and subsequently disassembling it for diagnostic purposes. Turbopump diagnostic disassembly is considered to be the visual inspection of all surfaces which move relative to other surfaces during normal operation. The turbopump is considered to have been operated at E-1 Engine conditions so all components are expected to have been exposed to neutron and gamma radiation. The turbine driving fluid was considered to be contaminated with radioactive particles from the reactor. A pictorial, chronological, step-by-step, remote-disassembly sequence is shown. (auth)

4803 (TID/SNA-3094) SMALL NUCLEAR ENGINE. (Aerojet-General Corp., Sacramento, Calif. (USA)). 28 Apr 1966. 45p. Dep. NTIS $5.00.

Declassified 24 Sep 1975.

Design study results and possible mission applications for a small Space Nuclear Engine (7,500 to 15,000 lb thrust) have been documented as presented to the Space Nuclear Propulsion Office. Curves of payload loss versus decreased engine thrust have been calculated for Jupiter fly-by missions. The reactor design is discussed in some detail. (LTN)

4804 (TID/SNA-3095) REVIEW OF AGC SOLID ROCKET PLANS AND PROCEDURES OF POTENTIAL APPLICATION TO THE NERVA PROGRAM. (Aerojet-General Corp., Sacramento, Calif. (USA)). 23 Nov 1965. 75p. Dep. NTIS $5.50.

Declassified 24 Sep 1975.

Since the total number of NERVA full-scale tests will be drastically restricted, full use must be made of the various techniques and procedures that have been found useful in attaining high reliability. Some of the SRO procedures and plans which are of particular interest to the NERVA program are: Comprehensive failure mode and effects analysis, nondestructive testing master plan, assurance of adequate design margin, overstress and peripheral testing (include some tests to destruction), variability analysis of test data, characterization and variability studies, rigid controls of materials and process, mission analysis to assure identification and specification of appropriate systems requirements, and qualification of all components at subsystem level when feasible. (auth)

4805 (TID/SNA-3103) NERVA CONTRACT SNP-1 WORK STATEMENT FOR PERIOD OCTOBER 1, 1965–SEPTEMBER 30, 1966. (Aerojet-General Corp., Sacramento, Calif. (USA)). 24 May 1966. 106p. Dep. NTIS $6.50.

A revised detailed list of the tasks and subtasks to be accomplished in the REON NERVA program in this contract year is provided. Many of the tasks are required for the NRX-A5, NRX-A6 and Xe-PRIME reactor, test facility modifications, and other support programs. (LTN)

4806 (TID/SNA-3107) POISON WIRE REMOVAL AND INSERTION ON GROUND, OCTOBER 1969 THRU FEBRUARY 1970. Interim Trade Study Report. Latin, E. (Aerojet-General Corp., Sacramento, Calif. (USA)). Mar 1970. 37p. Dep. NTIS $5.00.

A number of poison wire withdrawal/reinsertion device concepts were reviewed and evaluated with respect to the feasibility of each concept to provide a means of removing and replacing poison wires. The poison wires are inserted into the reactor core to guard against accidental criticality of the NERVA engine. In order to evaluate the poison wire concepts, a cursory functional flow diagram was prepared. The function of the wires during transportation, engine assembly, engine acceptance testing, stage assembly and checkout, and vehicle launch pad operations was then analyzed. Based on this study and Government recommendations, not one, but three poison wire withdrawal/reinsertion concepts were suggested to perform these functions. The assumptions and requirements upon which this decision was based are described. (auth)

4807 (TID/SNA-3118) PRESENTATION DATA FROM NUCLEAR ROCKET BIDDER'S CONFERENCE, 13–14 FEBRUARY 1961. Sogorka, J. J. (Aerojet-General Corp., Azusa, Calif. (USA)). 1961. 129p. Dep. NTIS $7.00.

Declassified 24 Sep 1975.

This presentation is concerned with the problems peculiar to pumps for nuclear rocket engines and pertaining to pumping liquid hydrogen. The purpose of the pump in these engines is to increase the fluid pressure level from that in the tank to the pressure desired at the reactor inlet. The pump must operate in a stable manner at one or more design operating conditions selected, as well as at all conditions encountered during the starting cycle. The major problem areas to be discussed are the selection and design of a pump to produce the required high-head rise, achieving a design suitable for the cavitation conditions encountered in liquid hydrogen, and the above mentioned problems of flow range and stability. New problems arise within this component because of the low density of the liquid hydrogen, which affects the pump-design and turbine-power requirements, and the high specific heat of gaseous hydrogen, which affects the turbine design characteristics. In addition, the turbopump design features will be a function of the type of feed system selected. These systems would include the topping, bleed, and gas generator systems. (auth)

4808 (TID/SNM-67) NATIONAL NUCLEAR ROCKET DEVELOPMENT FACILITY. Volume III of III. (Parsons (Ralph M.) Co., Los Angeles, Calif. (USA)). 16 Jun 1961. 290p. Dep. NTIS $10.25.

Declassified 23 Sep 1975.

A detailed description of the National Nuclear Rocket Development Facility includes sections on cryogenic facilities, instrumentation and control systems, support equipment, personnel accommodations, master plan and construction schedule. (LTN)

4809 (TID/SNM-68) CHRONOLOGY AND TIME EVENTS COLLATION. NRX/EST Test Series Experimental Plan IV. Watanabe, H. T. (Aerojet-General Corp., Sacramento, Calif. (USA)). 20 Mar 1966. 46p. Dep. NTIS $5.00.

Declassified 5 Nov 1975.

In this supplement the data for NRX-A4-EST EP-IV, a full

power run are given. The first attempt at a bootstrap start-up resulted in a flow shutdown, but the second was successful. Steady state reactor temperatures are given for various positions in the reactor. (LTN)

4810 (TID/SNM-70) KIWI-B-4D DESIGN REVIEW: NEUTRONICS, STRUCTURAL DYNAMICS, AND PROPOSED STARTUP PROGRAM. (Los Alamos Scientific Lab., N. Mex. (USA)). 1963. 139p. Dep. NTIS $7.00.

Declassified 26 Sep 1975.

After a review of the expected neutron properties of the KIWI-B4D reactor, considerable attention is given to possible problems resulting from fuel element vibrations, which were suspected as the cause of failure of the B4A reactor (fuel element ejection during test). Cold flow tests are planned before the actual reactor test. (LTN)

4811 (TID/SNM-74) NRX-A5 DRAGON MEMORANDA FOR EXPERIMENTAL PLAN III. Wright, J. (Aerojet-General Corp., Sacramento, Calif. (USA)). 1966. 131p. Dep. NTIS $7.00.

Twenty-four memos (Dragon memoranda) related to the performance testing of NRX-A5 EP-III are compiled. EP-III consisted of startup to a nominal 2000°R chamber temperature hold with limiter checkout, thermal calibration, and no-flux loop temperature controller response measurements; a demanded 50°R/sec ramp to the nominal design point using no-flux-loop temperature control; a hold at the nominal design point for the time duration consistent with Test Cell A liquid and gas capacity with limiter checkout and transfer function measurements made by perturbing turbopump rpm demand in fixed drum control; and a shutdown on a demanded −50°R/sec chamber temperature ramp, followed by scram and flow shutdown. All primary objectives of EP-III were met. The condition of the test article is satisfactory for full power operation. The objective of EP-IV, to operate at design point for the maximum time consistent with the Test Cell "A" liquid and gas capacity, is valid. (auth)

4812 (TID/SNM-76) CHRONOLOGY AND TIME EVENTS COLLATION. NRX/EST Test Series Experimental Plan III. Watanabe, H. T. (Aerojet-General Corp., Sacramento, Calif. (USA)). 8 Mar 1966. 58p. Dep. NTIS $5.50.

Declassified 7 Nov 1975.

The chronology, time events collation and temperature distribution data are given for the EP-III run of the NRX-A4-EST reactor test. This experimental plan was to have been primarily a mapping test after a bootstrap startup. The initial bootstrap was to have been accomplished with a dewar pressure of 35 psiz but this attempt was unsuccessful. Most of the mapping objectives of EP III were met after a successful bootstrap startup attempt with a dewar pressure of 70 psia. (auth)

4813 (TID/SNM-77) NRX-A5 DRAGON MEMORANDA FOR EXPERIMENTAL PLAN IV. (Aerojet-General Corp., Sacramento, Calif. (USA)). 28 Jun 1966. 80p. Dep. NTIS $6.00.

Declassified 5 Nov 1975.

Fourteen memoranda related to the full power EP-IV run of the NRX-A5 reactor test have been bound together. The reactor operated at the full power hold for 14 minutes and 27 seconds, reaching an average chamber temperature of 4090°R on startup and dropping below this at shutdown. At the end of this test the indicated end-of-run control drum angle suggested that further full power testing was unlikely. (LTN)

4814 (TID/SNM-78) NRX/EST PERFORMANCE EVALUATION DRAGON MEMORANDA EP IA DOUBLE PRIME. (Aerojet-General Corp., Sacramento, Calif. (USA)). 1966. 164p. Dep. NTIS $7.75.

The objectives of the EP IA double prime run of the NRX-A4-EST reactor test were incompletely met. Performance characteristics of the engine system during start-up at low power compared satisfactorily with CFDTS performance for the single successful cold flow run but the premature termination of the run series prevented the investigation of the performance characteristics over the ranges of dewar pressure and chamber pressure demand settings that were anticipated. The NRX/EST engine system appears to be in good condition except for several items of test car mounted auxiliary equipment. The difficulties with this auxiliary equipment, vent valve 1, vent valve 2, and the direct component shield and its cooling system must be resolved or the faulty items of equipment removed before the entire system will be in satisfactory condition for further testing. Since the experimental plan was terminated because of auxiliary component malfunctions before its objectives were achieved, there is no inherent reason to alter these objectives for the next experimental plan. Twenty-eight memoranda about the run are bound together in this document. (auth)

4815 (TID/SNM-80) CHRONOLOGY AND TIME EVENTS COLLATIONS. NRX/EST Test Series Experimental Plan IIB. Watanabe, H. T.; Snyder, C. R. (Aerojet-General Corp., Sacramento, Calif. (USA)). 8 Feb 1966. 26p. Dep. NTIS $5.00.

Declassified 7 Nov 1975.

The chronology, time events collations and temperature distribution data are given for run EP-IIB of the NRX-A4-EST reactor test. (LTN)

4816 (TID/SNM-81) REACTOR MATERIAL TEMPERATURES. NRX/EST Test Series Experimental Plan IIC. Meyer, L. F. (Aerojet-General Corp., Sacramento, Calif. (USA)). 18 Feb 1966. 16p. Dep. NTIS $4.50.

Declassified 7 Nov 1975.

In the NRX-A4-EST EP-IIC run the core axial temperature profiles behaved as predicted; however the core radial temperature profiles indicated peaking rather than the drop at the core periphery as predicted. The azimuthal temperature distribution indicates a hot spot in the core from about theta equal 50° to 160°. WANL reactor engineering recognizes that the core peripheral temperatures are higher than expected; however, this anomaly is not expected to limit the planned EP-III full power run. Tie rod exit gas temperatures showed good agreement with predicted values. The attempt to bootstrap with 45 psia dewar pressure was aborted due to a high tie rod exit gas temperature. Severe thermal transients occurred in the tie rod channels following flow shutdown. For 17 seconds prior to flow shutdown in Run 2, an oscillation occurred in the exit gas temperature which occurred at the same time as oscillations in other system parameters. The reflector temperatures behaved as expected during cooldown; however, at the start of cooldown of Run 1 the outer reflector was about 565°R, which exceeded the test limit. The outer reflector showed the same azimuthal temperature distribution as the core. (auth)

4817 (TID/SNM-82) NERVA ENGINE PERFORMANCE SENSITIVITY. Interim Briefing. (Aerojet-General Corp., Sacramento, Calif. (USA)). Sep 1966. 59p. Dep. NTIS $5.50.

Declassified 24 Sep 1975.

The sensitivity of reactor performance to variations in the principal engine design parameters was studied and the combination of design parameters resulting in the highest overall system performance selected. Slides of graphs involved in this process were presented at a briefing and have been documented. (LTN)

4818 (TID/SNM-83) NRX/EST PERFORMANCE EVALUATION. DRAGON Memoranda. EP-IIC. (Aerojet-General Corp., Sacramento, Calif. (USA)). 1966. 246p. Dep. NTIS $9.00.

Declassified 5 Nov 1975.

Twenty-nine memoranda on various aspects of the performance testing of the NRX-A4-EST reactor have been documented together. (LTN)

4819 (WANL-TME-240(Add.)) SELECTION OF TITANIUM FOR NRX-A REFLECTOR DOME END SUPPORT RING. Selz, A.; Hoppe, A. W. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 5 Jan 1963. 85p. Dep. NTIS $6.00.

Declassified 14 Jul 1975.

The selection of a material for the NRX-Al Reflector Dome End Support Ring is based upon several interacting mechanical considerations. Adequate strength is necessary. A low thermal expansion coefficient both lowers strength requirements and improves mechanical fit-up with the reflector. Similarly, a low elastic modulus reduces strength requirements. Materials considered included 9% nickel steel, austenitic stainless steels, aluminum alloys, titanium, Inconel X-750, and Inconel 600. The 9% nickel material was eliminated because of a loss of ductility at operating temperatures; the austenitic stainless because of their high thermal expansivity and high stresses; and Inconel 600 because of high stresses. Inconel X-750 exhibits marginal notch-sensitivity in cryogenic applications and was also eliminated. Aluminum was dropped because of its poor expansivity properties and relatively low strength. Only the 5% aluminum, 2-1/2% tin-Titanium alloy exhibited all the desirable characteristics delineated above, and was also deemed metallurgically adequate. In addition, the alloy not only maintains excellent strength over the operating temperature range, but also provides the added advantages of superior ductility and notched tensile strength when the iron content is properly controlled. A detailed review of the metallurgical characteristics and the limited irradiation effects data for this alloy indicated that no significant effects on properties should be observed as a result of the NRX-Al operation. Since the alloy provides adequate margin on reliability, it was selected for the support ring. (auth)

4820 (WANL-TME-777) WESTINGHOUSE ASTRONUCLEAR LABORATORY CONTRIBUTION TO THE SEVENTH MEETING OF THE PARTICLE FUELS WORKING GROUP, MAY 20–21, 1964. Evaluation of Fuel Particles. Boltax, A.; Fatzer, G.; Jacobs, D. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 13 May 1964. 37p. Dep. NTIS $5.00.

Declassified 14 Jul 1975.

Coated fuel particles are evaluated with respect to: Different vendors, damage in fabrication, fuel migration (as a function of temperature), mixed carbides (used to reduce migration), hydrolysis, etc. Microphotographic and microradiographic methods are used extensively in evaluating the coated particles. (LTN)

4821 (WANL-TME-1321) WESTINGHOUSE ASTRONUCLEAR LABORATORY CONTRIBUTION TO THE TWENTY-FIRST HIGH TEMPERATURE FUEL COMMITTEE MEETING, DECEMBER 14–16, 1965. Boltax, A.; Tobin, J. M. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Nov 1965. 33p. Dep. NTIS $5.00.

Declassified 14 Jul 1975.

The fuel element corrosion by hydrogen during the performance testing of the NRX-A2 and NRX-A3 reactors is described and the results compared to those of an electrically heated hydrogen corrosion test used to test development specimens. The data are analyzed in terms of two major mechanisms: Mid-range and high temperature corrosion. The total weight loss was of the order of 10 g per fuel element in NRX-A3 and in the electrical test; and 1 g for the NRX-A2 fuel elements (exposed for a much shorter time). Advanced coated particle fuel development is described and the ratio of carbon diffusion in refractory metal carbides (Nb, Ta, Ti, Zr and Hf) were determined and are reported. (LTN)

4822 (WANL-TME-1516) NR-1 THERMAL, FLUID FLOW, NUCLEAR AND RADIATION DESIGN STATUS REPORT. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 30 Sep 1966. 230p. Dep. NTIS $9.00.

Declassified 14 Jul 1975.

The status of the NR-1 reactor subsystem thermal and fluid flow, nuclear, and radiation design analysis as of September 30, 1966 is presented. A description of the basic configuration of the reactor and its components is included. Thermal and fluid analyses are primarily in the areas noted below: A reactor designed to provide 5000 MW thermal power with a 4500°R chamber temperature and a life capability of 60 minutes of operation at full power; A tie tube core support system modified to require a constant flow of 50 lb/sec regardless of tie tube coolant flow demand during reactor lifetime at full power operation, resulting in minimum perturbation in system performance; a lifetime reactivity control capability in the tie tube support system to provide a minimum power and temperature shift with core life; a 107-mil-diameter fuel channel with a 37 percent fuel void fraction (similar to the Phoebus-2A design) to permit increased application of Phoebus technology development; relocation of the shield below the support plate which provides a substantial weight savings; and a revised beryllium ring coolant distribution to increase thermal margins and reduce design sensitivity. Nuclear analysis of NR-1 was completed to the extent that no nuclear design problems appear to exist with the NR reactor that cannot be successfully resolved. The redesign of the fuel elements to include 0.110-inch reamed diameter flow channels resulted in a 20 percent reduction in the uranium inventory relative to the original design concept, i.e., from 300 kilograms to 235 kilograms. Should other considerations such as corrosion indicate that a smaller channel diameter is desirable, further substantial savings in the inventory could be realized. (auth)

4823 (WANL-TME-1539) WESTINGHOUSE ASTRONUCLEAR LABORATORY CONTRIBUTION TO THE TWENTY-THIRD HIGH TEMPERATURE FUEL COMMITTEE MEETING, NOVEMBER 29, 30, AND DECEMBER 1, 1966. Tobin, J. M. (ed.). (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Nov 1966. 40p. Dep. NTIS $5.00.

Declassified 15 Jul 1975.

The post-test appearance of NRX-A5 fuel elements was somewhat different from those in NRX-A4, in that surface corrosion effects and corrosion at the coated end were less pronounced. In addition, there was a higher incidence of broken elements in A5 than in A4 and the major weight losses were observed to occur in the element mid-band region rather than in the downstream half. As was noted in A4, the corrosion performance of the Y-12 elements again appeared to be somewhat better than that of the WAFF elements. Light interstitial corrosion streaks were again observed above the mid-band corrosion region. Pinholing in A5 was similar to that observed in the A4 reactor. During the last few months, considerable effort has been devoted to a study of the differences in hydrogen corrosion between electrical quality control tests and reactor performance of fuel elements. The data obtained from electrical tests show essentially linear weight loss with time whereas the reactor data indicate that weight loss is exponential with time. This apparent difference in corrosion behavior can now be explained. Analysis of data from electrical tests shows that the weight loss below 35 inches increases exponentially with time while the hot end weight loss increases linearly with time. Thus, the apparent linear behavior of the total weight loss in electrical tests resulted from examination of the sum of a linear and an exponential term. Note that the hot end weight loss in the reactor is significantly lower than that obtained in the electrical test. (auth)

4824 (WANL-TME-1611) WESTINGHOUSE ASTRONUCLEAR LABORATORY CONTRIBUTION TO THE TWENTY-FOURTH HIGH TEMPERATURE FUEL COMMITTEE MEETING, MAY 16–18, 1967. Fleischer, L. R. (ed.). (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). May 1967. 35p. Dep. NTIS $5.00.

Declassified 14 Jul 1975.

The fabrication of fuel elements for the NRX-A6 reactor involves two principles expected to improve fuel element performance: NbC protective coatings deposited to produce narrow cracks and overcoated with Mo. Parallel development efforts were undertaken to improve the graphite matrix by reducing permeability and susceptibility to corrosion. Theoretically, the solid solution carbide system UC-ZrC should be a promising system, which would be thermally stable up to about 2700°C (an increase of about 300°C). Phase studies have been carried out and a development program initiated. So far results have not been promising. Apparently due to the occurrence of UC_2, but some satisfactory results have been obtained with a single phase fuel structure, free of UC_2. The creep behavior of the transition metal carbides is being studied. (LTN)

4825 (WANL-TME-1720) WESTINGHOUSE ASTRONUCLEAR LABORATORY CONTRIBUTION TO THE 13TH COATED PARTICLE FUELS WORKING GROUP MEETING, 12–13 DECEMBER 1967. Fleischer, L. R.; Kilp, G. R. (eds.). (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Dec 1967. 27p. Dep. NTIS $5.00.

Declassified 10 Sep 1973.

The coatings (niobium carbide plus molybdenum) deposited on NRX-A6 fuel elements to protect them against corrosion by hydrogen at high temperature are described. The procedure for testing the corrosion performance of fuel elements in an electrically powered hydrogen corrosion test is discussed. The test aided considerably in the development of the coatings, which now reduce the corrosion by 5 or 6 times compared to uncoated fuel elements. Finally, the occurrence of severe hydrolysis of the fuel elements of XE-1, which was stored with 8 psig helium pressure for six months, is recounted and the research studies conducted as a result of this occurrence are discussed briefly. (LTN)

4826 (WANL-TME-1877) WESTINGHOUSE ASTRONUCLEAR LABORATORY CONTRIBUTION OF THE FOURTEENTH COATED PARTICLE FUELS WORKING GROUP MEETING, 20–21 November 1968. Fleischer, L. R.; Simmons, C. R. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Nov 1968. 35p. Dep. NTIS $5.00.

Declassified 14 Jul 1975.

The operation of the NRX-A6 reactor was highly successful. By comparison with previous NRX tests, NRX-A6 displayed high performance for a longer period of time and under more stringent conditions. The operating data and results for the NRX reactor series are summarized. The corrosion performance of the NRX-A6 fuel elements showed that a major improvement has been realized in the elimination of severe corrosion in the 0 to 30 inch region. The hot end performance indicated that extended fuel element life in high temperature operation and multiple restart capability will require further improvement. Advanced coated particle development to produce fuel beads resistant to thermal migration of uranium in the 2600°C to 2800°C range is discussed briefly. (auth)

4827 (WANL-TR-6524) [TRIP TO ORNL TO ATTEND ANNUAL NEUTRON PHYSICS DIVISION MEETING]. Woodsum, H. C. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 2 Oct 1970. 9p. Dep. NTIS $4.00.

4828 STUDY OF MARINE NUCLEAR REACTOR BEHAVIOR INDUCED BY SHIP'S MOTION. Kurosawa, A. (Kobe Univ. of Mercantile Marine (Japan)). Kobe Shosen Daigaku Kiyo. Dai-2-rui. Kokai, Kikan, Rigaku-hen; No. 22, 157-252(Aug 1974). (In Japanese)

45 refs.

A sinusoidal gravity change due to ship motion would cause

system variables such as fluid velocity, steam void and quality to oscillate with the same period but with some shift in phase. Phenomena related to subcooled boiling are considered to be important in considering the reactor's dynamic behavior induced by ship motion since marine reactors usually do not have very many bulk boiling voids within the core. Both natural circulation and forced flow systems were considered. An explicit equation for the inlet flow acceleration caused by ship motion as well as heat has been established, and numerically solved together with the continuity equation. To ascertain the combined effect to the flow behavior by the natural oscillation and by the periodic gravity field changes due to ship motion, both non-linear treatment and linear treatment were developed. These analysis results were compared with the experimental data of Michigan University. The results fairly well agreed with the data. To avoid the occurrence of resonance by proper thermal hydraulic and reactor dynamic, the theory fairly estimates the period of natural oscillation and the behavior of the system. (auth)

4829 EXAMINATION OF CAUSE OF "MUTSU" NEUTRON LEAKAGE. Technical Report Issued. At. Jpn.; 18: No. 11, 11-14(Nov 1974).

The subcommittee on shielding, a part of the committee set up to study the radiation shielding technology of the N.S. Mutsu, has finalized the results of its investigation, as follows: (1) Zero-power critical and low-power experiments showed the normal operation of the reactor itself. (2) High-energy neutrons leaked out through the gap between the reactor pressure vessel and the primary shield. (3) The neutrons tending downward after leakage through the gap caused a high level of neutron intensity in the lower part of the containment vessel. (4) No abnormality was observed in the radial direction in the primary shield. (5) The level of gamma-ray intensity within the containment vessel was normal. (6) Gamma-ray intensity at upper deck level was due mainly to capture gamma rays produced when the neutrons which had leaked through the gap were absorbed in the secondary shield. The course of investigations and subsequent analyses, leading to the above conclusions, are described, as well as the final results. (JA)

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Refer also to abstracts 2990–2995, 3008, 3017, and 3686.

4830 (ANCR-1163) EXPERIMENT DATA REPORT FOR SEMISCALE TRANSPARENT VESSEL COUNTERCURRENT FLOW TESTS. Hanson, D. J. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). Oct 1975. Contract E(10-1)-1375. 231p. Dep. NTIS $7.60.

Steady state air-water tests were performed as part of the Semiscale Blowdown and Emergency Core Cooling (ECC) Project to investigate downcomer countercurrent flow and downcomer bypass flow phenomena. These tests were performed in a plexiglass representation of the Semiscale pressure vessel which allowed changes to be made in the geometry of the upper annulus and downcomer for the purpose of investigating the sensitivity of downcomer and bypass flow to changes in system geometry. Tests were also performed to investigate the effects of two-phase inlet flows and different initial system pressures on countercurrent and bypass flow. Results for each test are presented in the form of computer printout of the measurements and of a summary of the pertinent calculated flow rates, pressures, and dimensionless volumetric fluxes. Descriptions of the test facility, instrumentation, operating procedures, and test conditions are also presented. An error analysis is presented for selected volumetric flux calculations. 10 references. (auth)

4831 (ANCR-1228) THERMAL-HYDRAULIC RESPONSE OF THE SEMISCALE MOD-1 SYSTEM: ISOTHERMAL TEST SERIES. Cartmill, C. E. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). Oct 1975. Contract E(19-1)-1375. 78p. Dep. NTIS $5.45.

Selected experimental thermal-hydraulic data from the recent isothermal blowdown test series performed in the Semiscale Mod-1 geometry are analyzed from an experimental viewpoint with emphasis on explaining differences between the data and expected results. Comparisons are made between the trends measured by the system instrumentation and the trends predicted by analytical tools, including the RELAP4 computer code, to aid in understanding the interactions between phenomena occurring in different parts of the system. The analyses presented are valuable for evaluating the adequacy and improving the predictive capability of analytical models developed to predict the system of a pressurized water reactor during a postulated loss-of-coolant accident (LOCA). 20 references. (auth)

4832 (ANL/WR-75-4) FIELD STUDIES OF THE THERMAL PLUME FROM THE D. C. COOK SUBMERGED DISCHARGE WITH COMPARISONS TO HYDRAULIC-MODEL RESULTS. Frigo, A. A.; Paddock, R. A.; McCown, D. L. (Argonne National Lab., Ill. (USA)). Jun 1975. Contract W-31-109-Eng-38. 35p. Dep. NTIS $4.00.

The Donald C. Cook Nuclear Plant at Bridgman, Michigan, uses submerged-diffuser discharges as a means of disposing waste heat into Lake Michigan. Preliminary results of temperature surveys of the thermal plume at the D. C. Cook Plant are presented. Indications are that the spatial extent of the plume at the surface is much smaller than previous results for surface shoreline discharges, particularly in the near and intermediate portions of the plume. Comparisons of limited prototype data with hydraulic (tank)-model predictions indicate that the model predictions for centerline temperature decay at the surface are too high for the initial 200 m from the discharge, but are generally correct beyond this point to the limits of the model. In addition, the hydraulic-model results underestimate the areal extent of the near and intermediate portions of the plume at the surface. Because this is the first report of a new field program, several inadequacies in the field-measurement techniques are noted and discussed. New techniques that have been developed to remedy these deficiencies, and which will be implemented for future field work, are also described. (auth)

4833 (CENPD-63(Rev.1)) 1/5 SCALE INTACT LOOP POST-LOCA STEAM RELIEF TESTS. Brodrick, J. R.; Burchill, W. E.; Lowe, P. A. (Combustion Engineering, Inc., Windsor, Conn. (USA). Nuclear Power Dept.). Mar 1973. 243p. Dep. NTIS $9.00.

The test program and experimental results for steam and emergency core cooling water interaction in the intact cold leg piping of a model of a pressurized water reactor are described. The program background and objectives are presented. The test apparatus and testing technique are discussed. Raw data and reduced data are presented in detail. (auth)

4834 (CONF-751013-9) IMPLICIT EULERIAN METHOD FOR ANALYZING TRANSIENT PHENOMENA IN FAST REACTORS. Wang, C. Y. (Argonne National Lab., Ill. (USA)). Oct 1975. Contract W-31-109-Eng-38. 12p. Dep. NTIS $4.00.

From 12th annual meeting of the Society of Engineering Science; Austin, Texas, USA (21 Oct 1975).

For Univ. of Texas, Austin.

An Eulerian compressible hydrodynamic method is presented for analyzing transient phenomena in nuclear reactors following hypothetical excursions. The method uses the implicit integration scheme to solve nonlinear equations of fluid dynamics in conjunction with a thin-shell analysis to calculate the response of the wall boundary. Detailed formulations are given. Results are presented for two example problems and compared with available experimental data. 6 references. (auth)

4835 (GEAP-14055) RADIOLOGICAL SOURCE-TERM MODELS FOR LMFBR HYPOTHETICAL CORE DISRUPTIVE ACCIDENTS. McDonald, J. W.; Cantrell, R. T.; Garrity, W. E.; Kriebel, A. R.; Stitt, R. K.; Teresi, J. D. (General Electric Co., Sunnyvale, Calif. (USA). Breeder Reactor Dept.). Jul 1975. Contract AT(04-3)-893. 108p. AT.

Generic models to analyze and evaluate radiological sources postulated to occur in hypothetical core disruptive accidents are developed. Activity during the first year was directed primarily to reviewing and evaluating state-of-the-art models used in radiological assessment analyses. The transport of radionuclides from the reactor core to regions surrounding the reactor vessel is divided into four phases: (1) disruption of the core and radionuclide release, (2) rapid discharge of radiological mixture from the core, (3) buoyant transport of radiological mixture to cover space, and (4) release of radionuclides from the reactor vessel. In addition, it is hypothesized that there may be a post-accident release of radionuclides as a result of the core melting through the reactor vessel. (73 references) (auth)

4836 (HEDL-SA-771) FUEL PIN TRANSIENT BEHAVIOR TECHNOLOGY APPLIED TO SAFETY ANALYSES. Presentation to AEC Regulatory Staff 4th Regulatory Briefing on Safety Technology, Washington, D.C., November 19–20, 1974. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Nov 1974. 301p. (CONF-741174-). Dep. NTIS $18.25.

From 4th regulatory briefing on safety technology; Washington, District of Columbia, USA (19 Nov 1974).

Information is presented concerning LMFBR fuel pin performance requirements and evaluation; fuels behavior codes with safety interfaces; performance evaluations; ex-reactor materials

and simulation tests; models for fuel pin failure; and summary of continuing fuels technology tasks. (DCC)

4837 (HEDL-TME-75-40) EVALUATION OF FFTF FUEL PIN TRANSIENT DESIGN PROCEDURE. Baars, R. E. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Sep 1975. Contract AT(45-1)-2170. vp. AT.

Data from Fuel Cladding Transient Test (FCTT) experiments and ANL loss-of-flow tests conducted in the TREAT facility are compared with fuel pin cladding burst pressures calculated using FFTF fuel pin transient operation design analysis procedures. The comparison is made for specimens irradiated in EBR-II to exposures of 30,000, 40,000 and 50,000 MWd/MTM, and for unirradiated specimens. Fuel pin response to unterminated rapid reactivity insertion events was also analyzed during the FFTF Plant Protective System (PPS) design. The conservatism of this analysis was demonstrated by predicting the time of fuel pin failure for several TREAT-simulated unterminated transient overpower tests with the design analysis procedure and comparing these predictions with the observed failure times. The principal conclusions from the evaluation are: The design procedure predicts conservative burst pressures for integral fuel pin cladding exposed in EBR-II up to 50,000 MWd/MTM. Coupled with the conservative design fission gas release assumption of 100 percent, it was further concluded that the FFTF fuel pin cladding integrity limit (defined as the temperature at which the design burst pressure equals the plenum pressure) is conservative to an exposure of at least 50,000 MWd/MTM. The design procedure predicts conservative (early) fuel pin failure times for rapid reactivity insertion events and the PPS response requirements based on the design procedure are conservative. (auth)

4838 (INIS-mf-1703, pp 306-318) POPULATION RADIATION SAFETY DURING NUCLEAR POWER PLANT OPERATION. Review. Gusev, N. G. 1974. (In Russian).

From jubilee conference dedicated to the twentieth anniversary of nuclear power engineering; Obninsk, USSR (25 Jun 1974).

In nuclear power plant operating experience and prospects of nuclear power engineering. Vol. 2. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow).

This review is composed of materials from the International Congress on Radiation Protection at Washington in September of 1973, from the symposium MAGATE on dosimetry problems of the environment in the vicinity of nuclear installations at Warsaw in November of 1973, and on supplemental materials. Primary attention is devoted to present-day tendencies of western scientists on the following problems: normalizing the population dose and the gas aerosol emissions from a nuclear power plant; estimating the dose from actual, gas-aerosol emissions; the goals and problems of monitoring the environment; and predicting the radiation dose to the population from nuclear power plant emissions. (tr-auth)

4839 (LA-6054PR) HTGR SAFETY RESEARCH PROGRAM. Progress Report, April-June 1975. Kirk, W. L. (comp.). (Los Alamos Scientific Lab., N. Mex. (USA)). Sep 1975. Contract W-7405-ENG-36. 55p. Dep. NTIS $5.45.

Progress in HTGR safety research is reported under the following headings: fission product technology; primary coolant impurities; structural investigation; safety instrumentation and control systems; phenomena modeling and systems analysis. (JWK)

4840 (NJD-23) IMPACT OF INCREASED NERVA REACTOR-ENGINE TESTING ON RADIOLOGICAL SAFETY. (Aerojet-General Corp., Sacramento, Calif. (USA); Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). Feb 1970. 208p. Dep. NTIS $8.75.

The NERVA reactor and engine test program presently contemplated for the Nuclear Rocket Development Station (NRDS) involves fission product releases considerably greater than those experienced previously, largely the result of more frequent and longer-duration tests; however, changes in nuclear fuel design could also substantially increase the quantity of fission products released. For these reasons, SNPO-C requested a preliminary evaluation of the radiological hazards (both on- and off-site) with a minimum of wind-direction constraints upon testing and evaluating the benefits of, or requirements for, a scrubber. In the case of an accident, it was found that the child's accidental milk ingestion dose exceeds the dose criterion to and beyond 100 miles if the accident occurs when the wind is 5 mph. The off-site adult and child thyroid inhalation doses under accident conditions may exceed the dose limits if the wind is blowing toward Section III. The on-site whole-body cloud dosages from the maximum postulated accident will be excessive to six miles from the test position. When firing at ETS-1 or E/STS-2 with the control point downwind, a 12-hour postaccident hold was found to be necessary for personnel before doses would be low enough for evacuation. Therefore, it is assumed that a 12-hour hold capability will be provided at the ETS-1/E/STS-2 control point. During normal operations the NERVA reactor releases fission products to the hydrogen exhaust. With 5 mph winds the limiting off-site dose using beaded fuel is the milk-ingestion dose which is excessive to 48 miles from the firing position. With composite fuels, off-site doses are acceptable provided a 90% efficient scrubber is used and milk controls are employed. Other details are given. (LTN)

4841 (NUREG-75/085) EVALUATION OF PRESSURE DROP ACROSS AREA CHANGES DURING BLOWDOWN. Quarterly Progress Report, April 1, 1975-June 30, 1975. (Cincinnati Univ., Ohio (USA). Dept. of Chemical and Nuclear Engineering). 1975. 20p. NTIS $3.25.

A series of blowdown experiments are to be conducted, with Freon 113 as the test fluid, in a well instrumented apparatus. Preliminary blowdown runs have been made using a slightly modified version of the apparatus used for previous oscillatory flow studies. These runs indicated the further system modifications required in order to obtain satisfactory performance. Steady state studies of two-phase pressure drop across abrupt area changes are being conducted to provide a firm data base for the transient tests. The tests have shown that the pressure drop behavior of restrictions depends on the length of the restrictions. A data correlation, which includes the effect of restriction length, is presented. (auth)

4842 (NUREG-75/090) REPORT TO THE CONGRESS ON ABNORMAL OCCURRENCES, JANUARY-JUNE 1975. (Nuclear Regulatory Commission, Washington, D.C. (USA)). Oct 1975. 35p. NTIS $3.75.

During the first half of 1975, no incidents or events occurred at the 53 licensed operating nuclear power plants which had an actual impact on or consequence to the health and safety of the public. However, although an adequate margin of safety was always present, some events did occur which involved a temporary but significant reduction in the level of protection. These three single, one recurring and three generic significant events were considered to be abnormal occurrences, and are reviewed in this report. The occurrence of these events has shown that the reliance on the defense-in-depth concept is sound for the protection of public health and safety. Although the reported events took place within the first six months of 1975, the descriptions, causes, and actions taken to prevent recurrence are reported based on status as of July 31, 1975. (auth)

4843 (ORNL-5050, pp 86-90) REACTOR SAFETY RESEARCH. Oct 1975.

In Chemical Technology Division annual progress report for period ending March 31, 1975. (Oak Ridge National Lab., Tenn. (USA)).

Reactor-safety related research included studies of fission product release from LWR fuel and transient release from LMFBR fuel. (JWR)

4844 (ORNL-5050, pp 91-92) NUCLEAR REGULATORY COMMISSION PROGRAMS. Oct 1975.

In Chemical Technology Division annual progress report for period ending March 31, 1975. (Oak Ridge National Lab., Tenn. (USA)).

Programs conducted for the US NRC included development of "as low as practicable" guides for the nuclear fuel cycle, safety review of nuclear facilities, and safety review of transport casks. (JWR)

4845 (ORNL-TM-5131) MONTHLY HIGHLIGHTS FOR OFFICE OF NUCLEAR REGULATORY RESEARCH PROGRAMS AT OAK RIDGE NATIONAL LABORATORY. Fee, G. G. (comp.). (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 33p. Dep. NTIS $4.00.

Brief summaries of reactor-safety-related research conducted for the US NRC are presented. (JWR)

4846 (UCLA-ENG-7582) PRELIMINARY ASSESSMENTS OF CARBIDE FUEL PINS DURING MILD OVERPOWER TRANSIENTS. Nickerson, G. M. (California Univ., Los Angeles (USA). Dept. of Energy and Kinetics). Oct 1975. Contract AT(04-3)-34. 78p. Nuclear Regulatory Commission, Washington, DC.

Thesis.

The work presented deals with safety considerations for Liquid Metal Fast Breeder Reactors fueled with mixed carbides. Beginning with a literature survey that reviews a variety of topics germane to carbide fuel development and safety research, general characteristics concerning this advanced fuel are presented. Further, an evaluation of the future needs for experimental and analytical research efforts is presented. A preliminary investigation of the unprotected transient overpower accident sequence postulated

for a large carbide fueled reactor is also presented. The HOPE computer code is the computational tool used to analyze a conceptual core design fueled with mixed carbides of uranium and plutonium. The details of this design are presented and compared with those of the Clinch River Breeder Reactor Plant. Results of HOPE calculations for both helium and sodium bonded carbide fueled cores are presented and compared with a similar study performed on an oxide core. Conclusions are drawn based on the findings of the preliminary transient overpower studies conducted. Recommendations are made where HOPE code improvements are needed. (auth)

4847 (UEC-AEC-740107) REVIEW OF UNDERGROUND SITING OF NUCLEAR POWER PLANTS. (United Engineers and Constructors, Inc., Philadelphia, Pa. (USA)). Jan 1974. Contract AT(11-1)-2226. 159p. Dep. NTIS $11.00.

A review of the potential for the underground siting of nuclear power generating plants has been undertaken. The review comprised a survey and assessment of relevant published documents currently available, together with discussions with Government sponsored agencies and other bodies, to evaluate the current status of technology related to the design and construction of underground nuclear power plants. It includes a review of previous work related to the underground siting of power plants and other facilities; a preliminary evaluation of the relative merits of the various concepts of undergrounding which have been proposed or constructed; a review of current technology as it relates to the requirements for the design, construction and operation of underground nuclear power plants; an examination of the safety and environmental aspects; and the identification of areas of further study which will be required if the underground is to be established as a fully viable alternative to surface siting. No attempt has been made to draw final conclusions at this stage. Nothing has been found to suggest that the underground siting concept could not provide a viable alternative to the surface concept. It is also apparent that no major technological developments are required. It is not clear, however, whether the improvements in safety and containment postulated for the underground can be realized at an economic cost; or even whether any additional cost is in fact involved. The problem is essentially site dependent and requires further study for which recommendations are made. (auth)

4848 (WANL-TME-524) SAFEGUARDS AGAINST ACCIDENTAL CRITICALITY DURING NERVA CORE SHIPMENT. Hemmerle, E. H. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Sep 1963. 47p. Dep. NTIS $5.00.

Declassified 14 Jul 1975.

The safety precautions taken to protect against accidental conditions of criticality or the loss of radioactive material during shipment of NERVA core and reactor assemblies are described. The consideration has been limited to "gate-to-gate" movements since the operations of core assembly, loading and unloading the shipping container and subsequent use of the reactor are subjects of separate safety evaluation. The shipping container used for movement of the reactor from the WANL Reactor Assembly Area to the test site is described. Briefly it is a double containment system, designed to insure that the reactor arrives at its destination without damage through normal transportation and handling and to protect against accidental criticality or loss of special nuclear or radioactive material in the event of a major accident. In addition to the container, a shipping poison wire system is used which will maintain the reactor subcritical even in the event of flooding with water or other hydrogeneous material. Bureau of Explosive approval of the shipping container will be obtained. (auth)

4849 (WCAP-8370(Rev.8)) QUALITY ASSURANCE PLAN, WESTINGHOUSE NUCLEAR ENERGY SYSTEMS DIVISIONS. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Nuclear Energy Systems Div.). Sep 1975. 160p. Westinghouse Electric Corp., Pittsburgh.

The Quality Assurance Plan used by Westinghouse Nuclear Energy Systems Water Reactor Divisions is described. The purpose of the program is to assure that the design, materials, and workmanship on Nuclear Steam Supply System (NSSS) equipment meet applicable safety requirements, fulfill the requirements of the contracts with the applicants, and satisfy the applicable codes, standards, and regulatory requirements. This document replaces the contents of Chapter 17 Safety Analysis Reports, except for any special or unique requirements. (auth)

4850 (XN-75-41(Rev.1)(Suppl.5)) SUPPLEMENTARY INFORMATION RELATING TO BLOWDOWN AND HEATUP ANALYSIS. Supplement 5, Revision 1. (Exxon Nuclear Co., Richland, Wash. (USA)). 3 Oct 1975. 173p. Exxon Nuclear Co., Richland, WA.

Revision 1 of Supplement 5 provides additional information principally relating to calculation of BOCREC, modifications to RELAP to maintain calculational stability during reflood and retention of primary coolant in the lower plenum. Items revised or added are denoted by lining in the right hand margin. This supplement is divided into nine sections pertaining to blowdown, hot channel, reflood, TOODEE2, small break analysis, and computer code modifications. (auth)

4851 (XN-CC-32NP) XTRAN-PWR: A COMPUTER CODE FOR THE CALCULATION OF RAPID TRANSIENTS IN PRESSURIZED WATER REACTORS WITH MODERATOR AND FUEL TEMPERATURE FEEDBACK. Morgan, J. N. (Exxon Nuclear Co., Richland, Wash. (USA)). 7 Oct 1975. 69p. EXXON Nuclear Co., Inc., Richland, WA.

XTRAN is a two dimensional (r-z) computer program which solves the space and time dependent neutron diffusion equation with fuel temperature and moderator density reactivity feedbacks. XTRAN utilizes a nodal method based directly on the one-group finite difference technique for the solution of the time-dependent neutron diffusion equation. The neutronic model incorporated by XTRAN is capable of following a rapid reactor transient initiated by a reactivity insertion caused by a control rod being removed from the core or by pressure or temperature changes in the moderator. The core utilizes two-dimensional (r-z) geometry and by doing so is capable of following the rapidly changing flux distribution as a control rod leaves the core and the scram rod bank simultaneously enters the core. (auth)

4852 NUCLEAR REACTOR PROTECTION SYSTEM AVAILABILITY ANALYSIS. Grimm, K. N. Ann Arbor, MI; Univ. of Michigan (1975). 235p. University Microfilms Order No. 75-20,357.

Thesis (Ph. D.).

Nuclear power reactors use a protection system to terminate reactor operation when an abnormal condition arises. To have a protection system capable of correct operation when there may be failures of items in the protection system, several channels are used to monitor the reactor. These channels are coupled to a deciding mechanism (called a logic matrix) whose output (continued operation or shutdown) is dependent on the channel indications as to the state of the reactor and the type of logic used in the matrix. The system output pointwise (operating correctly probability at time t) or interval availability (average pointwise availability over a given time interval) is analyzed for a protection system comprised of n identical independent channels coupled to a perfect logic matrix. The channels are modeled by single items with two failure modes (fail-safe and fail-dangerous), constant failure hazard rates, a constant fail-safe repair hazard rate and a constant "failure" hazard rate from the fail-safe mode to the fail-dangerous mode. The constant failure hazard rate from the fail-safe mode to the fail-dangerous mode is used to model imperfect repair. The analysis includes the calculation of several optimal properties, optimal in the sense that the system output pointwise or interval availability is a maximum. An analysis of a system comprised of n identical independent channels coupled to a perfect logic matrix is also presented using either the system mean time to fail-dangerous or the system mean fractional dead time, instead of the availability, as the system figure of merit. The system mean fractional dead time is the mean fractional amount of time that the system is in the fail-dangerous mode averaged over the time interval between regular system testing. It is shown that using only the system mean time to fail-dangerous or the system mean fractional dead time as the system figure of merit may lead to a system that is unacceptable from an operational point of view. (Diss. Abstr. Int., B)

4853 THEORETICAL INVESTIGATION OF THE QUENCHING OF NUCLEAR REACTOR FUEL RODS FOLLOWING EMERGENCY CORE COOLANT INJECTION. Carbiener, W. A. Columbus, OH; Ohio State Univ. (1975). 136p. University Microfilms Order No. 75-19,419.

Thesis (Ph. D.).

An investigation is performed to formulate a calculational model to describe one aspect of the reflooding process following the injection of emergency core coolant subsequent to a nuclear reactor loss-of-coolant accident. The rate of quench front progression is an integral part of the safety analyses pertaining to power reactor system performance and to the design and development of emergency core cooling systems. A one-dimensional calculational method is developed centered around a moving control volume located at the quench front. Energy and mass balances are applied to the control volume to determine the quench front movement as a function of local inlet and outlet fluid conditions. The moving volume is coupled to the core inlet by a transient heat transport relationship that considers the axial and temporal power characteristics of the fuel rod. This approach requires the knowl-

edge of the fuel rod quench temperature, the liquid entrainment velocity, and the two-phase mixing efficiency at the quench front which are derived empirically from the PWR–FLECHT experiments. A step-wise calculational procedure results which is used to determine the quench front velocity as a function of time and fluid channel inlet conditions. The calculational method is compared to a series of PWR–FLECHT experiments and found to properly account for changes in power, coolant flooding rate, pressure, and inlet subcooling. Additionally, it is used to predict the quench front progression rate for a power reactor under postulated accident conditions. Sensitivity calculations with respect to coolant subcooling and reflood rate are presented to illustrate the type of safety and design information that can be provided by the model. (Diss. Abstr. Int., B)

4854 INFLUENCE OF SAFETY CRITERIA ON DESIGN OF INSTRUMENTATION SYSTEMS IN PWR PLANTS. Authier, J. C. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92–Courbevoie (France)). pp 26-28 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975).

The main safety criteria used for the design of instrumentation systems are recalled: single-failure criterion, capability for instrumentation channel checks during normal operating conditions, and control and protection systems interaction. It is shown that the protection systems of four-loop PWR power plants fully meet safety requirements of a nuclear installation. (FR)

4855 NEW CONTAINMENT CONCEPT FOR LIGHT-WATER REACTORS: DOUBLE SHIELD WITHOUT BARRIER SEAL. Costaz, J. L. (Electricite de France, 92–Courbevoie. Service Etudes et Projets Thermiques et Nucleaires). pp 30-31 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975).

A new containment system has been developed by EDF for its future PWR power plants (1350 MW). It comprises one internal prestressed concrete enclosure without barrier and one external reinforced concrete enclosure. The research and development program includes concrete seal tests, the detection of leaks on structures, and the performance of structures under projectile impact. These tests as well as the study of the radiological effects of accidental loss of primary coolant show that this type of containment marks a definite step from the point of view of safety, as compared with systems of prestressed concrete plus metallic barrier. (FR)

4856 RECENT METHODS OF STRUCTURAL ANALYSIS FOR NUCLEAR REACTORS. CEA-SEMT Computer Codes. Goldstein, S.; Hoffmann, A.; Jeanpierre, F.; Livolant, M.; Roche, R. (CEA Centre d'Etudes Nucleaires de Saclay, 91–Gif-sur-Yvette (France). Service des Etudes Mecaniques et Thermiques). pp 35-38 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975). (American Nuclear Society, Hinsdale, Ill.).

A large system of stress analysis computer codes, based on the finite element method, was developed at Saclay. The results were compared to elasticity and plasticity tests on reactor components. For plane and axisymmetric geometries the real behavior of materials was analyzed. Specific codes were developed for axisymmetric thin shells, three-dimensional shells, three-dimensional massive structures, and piping systems. These programs take into account plasticity, creep, thermoplasticity and dynamical phenomena (earthquakes, explosions, ruptures). (FR)

4857 EXPERIENCE GAINED AT THE PHENIX REACTOR WITH REGARD TO PROTECTION ASPECTS. Goddet, J. (CEA Centre de Marcoule, 30–Bagnols-sur-Ceze (France). Service de la Centrale Phenix); Peyresblanques, H.; Galissian, F.; Meffre, P. (CEA Centre de Marcoule, 30–Bagnols-sur-Ceze (France). Service de Protection Contre les Radiations). pp 72-73 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975). (American Nuclear Society, Hinsdale, Ill.).

Control devices provided for at the Phenix reactor during the first operating period are described. They are intended to prevent hazards inherent to this power plant: radioactivity hazards, specific sodium risks and conjunction of sodium risks with radioactivity hazards. (FR)

4858 NATURE AND FINALITY OF LIABILITY INSURANCE SUPPORT TO NUCLEAR OPERATORS. Deprimoz, J. (Pool Francais d'Assurances des Risques Atomiques, 75–Paris). pp 296-297 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975).

First the specific features of the law originated from the Paris Convention of 1960 is described. Strict liability is placed on the operator. The specific services expected from the liability insurer are reviewed, and the method used for rating the risks is analyzed. The new rating techniques that could be justified by speeding up the erection program of nuclear plants through the world are surveyed. (FR)

4859 PRODUCTION OF NUCLEAR ENERGY AND THE RISKS OF LOW DOSES OF IONIZING RADIATION IN MAN. Barendsen, G. W.; van Bekkum, D. W.; van Putten, L. M. (Gezondheidsorganisatie TNO, Rijswijk, Netherlands). Med. Contact; 74: No. 7, 300-304(Jul 1974). (In Dutch)

4860 STUDY ON THE PREVENTION OF BRITTLE FRACTURE OF PRESSURE VESSELS. Imamasa, J.; Miki, T. (Mitsubishi Heavy Industries Ltd., Takasago (Japan). Takasago Works). Mitsubishi Juko Giho; 11: No. 6, 813-823(Nov 1974). (In Japanese)

In order to verify the application of linear fracture mechanics, twelve pressure vessel models were ruptured under static pressure and fluctuating pressure. Six of them were ordinary cylinders and the remaining six were cylinders with angular distortion in circumferential direction. From the results of the test, a prospect as to the possibility of the leak-before-fracture design was obtained (leakage occurs with the penetration of the initial crack, which is caused by several cycles of application of fluctuating pressure, through the wall thickness, thereby preventing fracture of the vessel). To improve the accuracy of life prediction of pressure vessels it is necessary to pursue further studies on the stress intensity factor of a surface crack which is subjected to tension and bending force and on the development of cracks in the depth and length directions. (auth)

4861 5 MREM GUIDE PROPOSED FOR "AS LOW AS PRACTICABLE"—VERY HARD TO ELEC. INDUSTRY. At. Jpn.; 18: No. 11, 15-27(Nov 1974).

Under the control of the Coordination Committee of the Environmental Safety Special Committee (ESSC), five subcommittees were set up to look into particular problems: (1) environmental radiation, (2) nuclear safety, (3) effects of low level radiation, (4) disposal of solid radioactive wastes, and (5) liquid effluents. The report by the Coordination Committee contains the suggestions made for the improvement of nuclear regulation and ways of winning the understanding and cooperation of the people on nuclear development. In order to strengthen the structure of the system for reactor safety, the Committee has made proposals which were the outcome of careful consideration of the policy capable of practical application. Another recommendation was on the "as low as practicable" idea. The report by the Section Committee on Environmental Radioactivity contains recommendations to set the numerical guides for planning design objectives and limiting the conditions for operation to meet the criterion set, viz. "as low as practicable," applied to radioactive substances in the effluent from light-water-cooled nuclear power reactors. The values proposed are 5 millirems to whole body, and 15 millirems of ^{131}I to thyroid, which indicate dose objectives around the sites of LWRs for one year exposure. (JA)

4862 ECCS PRACTICE IN REACTOR INSTRUMENTATION. Suguri, S. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). Keiso; 18: No. 2, 35-38(Feb 1975). (In Japanese)

ECCS is installed in consideration of the supposed breakage of the reactor primary cooling system, though the piping is designed so that a break leading to the leakage of a large quantity of primary coolant does not occur. However, since it is the last back-up system in an emergency, its function must be fully demonstrated at the time of reactor failure. For this reason, the design principles are as follows: (1) high reliability and ample redundancy, (2) the test and inspection for checking function can be carried out while a reactor is in operation or during shut-down, (3) continuous securing of necessary power or other driving source

and water supply. The components of the recent ECCS system for BWR-type 5 are automatic pressure relief valve, high pressure core spray system, low pressure core spray system and low pressure core injection system. The application of the design principle to the actual system is described. In PWRs, the ECCS system consists of three systems of accumulator tank, high pressure injection, and low pressure injection. Design concepts are the same as those of BWRs. (JA)

4863 EMERGENCY COOLING SYSTEM FOR NUCLEAR REACTORS. Sawai, S.; Akebi, M.; Suzuki, E. (to Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Japanese Patent 1973-31198/B/. 7 May 1968. 2p. (In Japanese)

An emergency cooling system for a heavy water moderated boiling light water cooled reactor having a positive void coefficient is provided, in which the outlet piping of an emergency cooling pump sucking water in an emergency cooling water pond and normally pressurizing it to a pressure lower than that of the coolant within subheaders of a reactor cooling system is coupled through two check valves to each of the subheaders, while the outlet piping of a seal pump sucking make-up water and normally pressurizing it to a pressure slightly higher than the coolant pressure within the subheaders is connected through a check valve to a conduit between the two check valves. In the steady running condition, the make-up water under the higher pressure flows into the subheader through one of the two check valves, so that the contaminated water of the cooling system does not flow backward. In emergencies in which the light water of the cooling system flows outside thereof and the coolant pressure drops, the reactor is shut down, and simultaneously therewith, the pressurized emergency cooling water as well as the make-up water is supplied through the subheaders into respective pressure tubes in a reactor core tank in immediate response to the pressure drop. (JA)

4864 EMERGENCY COOLING SYSTEM FOR PRESSURE TUBE-TYPE REACTORS. Higashi, M. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1974-7837/B/. 8 Nov 1968. 3p. (In Japanese)

When high pressure water is fed at the outset of a reactor accident, the high pressure water is transferred smoothly to the low pressure water by the emergency cooling system of a pressure tube-type reactor, effectively cooling the core. The reactor is fitted with a header distributing cooling water which flows through the pressure tube loaded with fuel. A system causes the high pressure water to flow to the underside header, while another system causes a low pressure water flow to the same header. After feeding a definite quantity of high pressure water to the core, the cooling water in a tank is absorbed and mixed with the high pressure water; the mixed water at medium pressure is caused to flow to the header. When the low pressure water system is activated at a given pressure, the medium pressure water system is designed to cease. During the operation of the latter system another system is designed to feed the cooling water from the low pressure water system to the high pressure water system. The medium pressure water feeding system provided between the low and high pressure water feeding systems allows an adequate, minimum quantity of high pressure water to be fed to the core, with a smooth transfer from the high pressure water feeding system to the low pressure water feeding system, thus being effective for pressure-type reactors with a small quantity of core water. (JA)

4865 PRESSURE TUBE-TYPE REACTOR. Aizu, Tadashi; Iwajima, S. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1974-8676/B/. 25 Nov 1968. 4p. (In Japanese)

When pressure in a calandria tank increases as a result of an accident, a pressure increase can be prevented by a thin-walled calandria tank. The pressure tube-type reactor is provided with a calandria tube external to the pressure tube arranged in the shape of a lattice. The primary cooling water is caused to flow in the pressure tube. The core is designed to be dipped in heavy water. A buffer gas section is provided in the upper part of heavy water. In order to strengthen the calandria tube therein with the calandria strengthening member, one part is mounted on the upper part of the calandria tank while the other part is dipped in heavy water. Thus, the calandria tube in the helium section is designed to be pressure resistant. Even if the pressure tube is damaged, the calandria tube prevents damage to the section adjoining the heavy water, injecting high pressure steam and water into heavy water. Accordingly, steam injected into the heavy water is condensed; pressure in the calandria tank can be reduced to the minimum in comparison with injection into the helium section. Furthermore, the retaining of the calandria tube and the strengthening thereof in the helium section allows the calandria tube to escape damage, and pressure in the calandria tank does not increase abnormally. Therefore, the calandria tank wall may be thinned. (JA)

4866 PRESSURE TUBE TYPE REACTOR. Ogasawara, H. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1974-23520/B/. 26 May 1969. 4p. (In Japanese)

It has been proposed that, when a loss-of-coolant accident occurs in a heavy-water-moderated light-water-cooled pressure tube type reactor, the heavy water dump which introduces the heavy water of a calandria tank into a heavy water dump tank be performed in order to reduce neutrons involved in the reaction. As the result of the heavy water dump, however, the ability to cool fuel elements is diminished, and the elimination of decay heat is difficult. Although it is considered to cool the fuel elements by pouring heavy water over the outside surfaces of the calandria tubes, means for uniform heavy water flow are complicated and the reliability of operation is questionable. According to this invention, a heavy water retaining tube which is open at the top is provided in a manner to surround each calandria tube. Even when the heavy water dump is conducted, heavy water remains within the heavy water retaining tube. Thus, the decay heat of the fuel element in a pressure tube is transmitted through the calandria tube to the remaining heavy water. The fuel element is therefore reliably cooled. (JA)

4867 ANALYSIS OF ESCAPE OF RADIATION INTO ROOMS WHEN PIPES FAIL. Chechetkin, Yu. V.; Kizin, V. D.; Kobzar, I. G.; Shmelev, V. E.; Yakovleva, E. D. Therm. Eng. (USSR) (Engl. Transl.); 21: No. 10, 53-57(1974).

Translated from Teploenergetika; 21: No. 10, 40-43(1974).

An analysis is presented of the variations of the main technological parameters of a reactor with loss of tightness of the main pipes for a long time in the zone of the connections of the reactor. These cases have most serious consequences in boiling single-loop vessel type nuclear power stations. Calculations have been related to nuclear power stations with VK-50 reactors. (auth)

4868 SUMMARY OF RADIOACTIVITY RELEASED IN EFFLUENTS FROM NUCLEAR POWER PLANTS DURING 1973. Nucl. Saf.; 16: No. 6, 734-738(1975).

Releases of radioactivity in airborne and liquid effluents and the number of shipments and activity of solid waste have been compiled by the Nuclear Regulatory Commission from license reports for 1973. The wide variations in the radioactivity releases were due to differences in plant size, power level, fuel performance, and effluent-treatment methods. Data covering specific isotopes of particular interest are summarized. In all cases, releases of radioactivity were only small fractions of permissible limits set by applicable regulations or in technical specifications. (auth)

4869 FRAGMENTATION MODELING RELATIVE TO THE BREAKUP OF MOLTEN UO_2 IN SODIUM. Cronenberg, A. W.; Grolmes, M. A. Nucl. Saf.; 16: No. 6, 688-700(1975).

An important aspect of the fuel-coolant interaction problem relative to liquid-metal-cooled fast breeder reactor safety analysis is the fragmentation of molten oxide fuel on contact with liquid-sodium coolant. A proper description of the kinetics of such an event requires an understanding of the breakup process and an estimate of the size and dispersion of such finely divided fuel in the coolant. In recent years, considerable interest has centered on the problem of determining the nature of the fragmentation process. This article reviews both analytic and experimental studies pertaining to such breakup in light of recent developments in the understanding of heat-transfer and solidification phenomena during quenching of UO_2 in sodium. Where possible, an attempt is made to assess the work potential for fragmentation of the various proposed models and to compare the predicted particle size with experimental results. (auth)

4870 SAFETY INSTRUMENTATION FOR THE SODIUM-COOLED FAST REACTOR. Hall, R. S. (Berkeley Nuclear Labs., England). Nucl. Saf.; 16: No. 6, 701-713(1975).

The particular safety problems of the fast reactor and the role of instrumented protection in relation to the overall safety design of the reactor are discussed. The importance of the accident sequence arising from a fault within one subassembly is indicated, and the physical phenomena involved are discussed with regard to the generation of detectable signals. Several possible techniques for detecting subassembly accidents are described, including those with detectors situated at the outlet of each subassembly and also those involving whole-core parameters. Reference is made to the way in which types of instruments would have to be combined to give a high degree of protection to the system, the actual protection required being dependent on the overall safety intentions. Attention is drawn to the problems of minimizing the spurious trip rate for a well-instrumented reactor, which lead to stringent requirements on instrument-reliability and/or replaceability. The possible role of the computer in handling the multiplicity of complex signals is mentioned, together with the problems that have to be solved

before this can be done. It is concluded that satisfactory instrument protection is available for whole-core faults, but with regard to subassembly fault detection the situation is less clear. Although some information is available for guidance on the instruments and their specifications, the justification and achievability of the latter are dependent on development work that is still proceeding. It may well be that uncertainties concerning the effects of the reactor environment will require that some of this work take the form of in-reactor experiments. (auth)

4871 EPRI WATER-REACTOR SAFETY PROGRAM. Loewenstein, W. B. (Electric Power Research Inst., Palo Alto, CA). Nucl. Saf.; 16: No. 6, 659-666(1975).

The rationale, structure, and current status of the Electric Power Research Institute (EPRI) Water-Reactor Safety Program are summarized. The efforts emphasize quantified assurance of safety, usually based on the synthesis of pertinent experimental, analytical, and calculational results. The scope of the program ranges from the quantified definition of the course of the postulated loss-of-coolant accident to continuing routine monitoring of the pressure boundary. This includes research on such diverse efforts as two-phase flow behavior in complex geometries, interaction of potential tornado-generated missiles with reinforced-concrete structures, aspects of probabilistic safety appraisal, and techniques to quantify the diagnosis of the performance of the pressure boundary. The EPRI program efforts are coordinated with the needs of the utility industry through several advisory committees. The program is coordinated with the programs of national sponsoring agencies and maintains liaison with reactor vendors and architect-engineers. Program segments are implemented by reactor vendors, architect-engineers, consulting organizations, national laboratories, independent research organizations, and universities. In addition to coordination with national agencies, arrangements for cooperation and exchange have been initiated with several foreign national and utility organizations. (auth)

Reactor Theory and Calculation

4872 (EUR-5339e) METHOD TO SOLVE THE INTEGRAL TRANSPORT EQUATION EMPLOYING A SPATIAL LEGENDRE EXPANSION. Hartman, J. (Commission of the European Communities, Ispra (Italy). Joint Research Centre). 1975. 34p. Dep. NTIS (US Sales Only) $5.00. EUR FB 125,-.

The study of the eigenvalues of the Boltzmann operator is the mathematical framework to investigate the decay behavior of a neutron population in moderating materials. Among the various methods to solve the neutron transport equation the one based on Legendre polynomial expansion is presented. Expanding the neutron flux or density in a series with respect to Legendre polynomials leads to a linear system of equations for the expansion coefficients. An important feature of the method is the possibility of representing the matrix elements of the linear system in analytical form. The aim of this work is to find the discrete eigenvalues in different finite geometries. A FORTRAN code to solve the problem in the case of slab- and spherical geometries has been established for a given scatterer material. 11 references. (auth)

4873 (VTT-YDI-1) TRIGON: A TWO-DIMENSIONAL MULTIGROUP DIFFUSION CODE FOR TRIGONAL OR HEXAGONAL MESH. Kaloinen, E. (Valtion Teknillinen Tutkimuskeskus, Otaniemi (Finland). Ydinvoimateknikan Lab.). May 1973. 75p. Dep. NTIS (US Sales Only) $6.75.

The multigroup two-dimensional neutron diffusion code TRIGON is described. The code finds a solution to the time-independent diffusion equation by the finite-difference method using five-point difference equations in a uniform trigonal or hexagonal mesh. The difference equations are solved by a line over-relaxation technique with a special asymptotic flux extrapolation and a region rebalancing method for convergence acceleration. An arbitrary group scattering matrix is allowed and the code can perform both eigenvalue or k-effective and inhomogenous or fixed source calculations. TRIGON is written in Fortran V for UNIVAC 1108 but the programming features differing from Fortran IV have been mostly avoided. 5 references. (auth)

4874 INTERPRETATION OF FLUX SHAPE TRANSIENT WITH CONCEPTS OF "REGION OF UNITY" AND "REGION OF INFLUENCE." Kawai, T. (Hitachi Ltd., Kawasaki, Kanagawa (Japan). Atomic Energy Research Lab.). J. Nucl. Sci. Technol. (Tokyo); 12: No. 1, 35-42(Jan 1975).

Concepts of "region of unity" and "region of influence" are introduced to interpret space-time flux behavior in general. The normalized fractional power change U is first defined by $U(r,t) \equiv f/\max_r f$, where $f \equiv \delta \varphi (r,t)/\varphi_0 (r)$ is the fractional power change. The factor of unity is then defined by $u(t) = \min_r U(r,t)$. The fractional power change throughout the core is therefore estimated within the limits of [u,1]. If the flux shape does not change, u is always equal to unity in a reactor core: u can be a measure of coupling strength or "degree of unity" of the transient flux distribution inside a core. The region of unity is finally defined to be a region in which the normalized fractional power change U is larger than a predetermined number close to 1 (0.8 for example). The region of influence is similarly defined to be a region in which the normalized fractional power change U is larger than a predetermined number which is close to 0 (0.1 for example). Analysis on a model aimed at simplification leads to the conclusion that the factor of unity depends on two parameters—size of the core and that of the inserted disturbance. The former element has already been recognized as an essential factor in space dependent kinetics, but now the latter element is shown to be the more important parameter. In most cases, the radii of the regions of unity and of influence are of the same order as the radius of disturbance. (auth)

4875 NUMERICAL SOLUTION OF THE MULTIGROUP DIFFUSION EQUATION IN ONE-DIMENSIONAL GEOMETRY. Pavelescu, M.; Adam, S. Rev. Roum. Phys.; 20: No. 2, 173-178(1975).

An algorithm is derived, in the one-dimensional diffusion approximation, for critical calculation of three-zone fast reactors. The algorithm, which was implemented on computer as the STL-5 code, is equally valid for finite rectangular, cylindrical, and spherical reactors. Some numerical results illustrate the performances of this code. (auth)

4876 FAST REACTOR OPTIMIZATION BY A METHOD OF NONLINEAR PROGRAMMING. Pavelescu, M.; Dumitrescu, H.; Adam, S. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 20: No. 2, 179-184(1975).

A non-linear programming method for the material distribution optimization in a fast reactor is presented. As a reactor is described by some parameters such as critical mass, power, specific power, breeding ratio, etc...., the method permits one to maximize (or minimize) one of these parameters with restrictions (equalities or inequalities) concerning the others. For illustrating this method, a simple application is given. (auth)

4877 COMPUTATIONAL ANALYSIS AND EVALUATION OF THE FINITE ELEMENT METHOD FOR A CLASS OF NUCLEAR REACTOR CONFIGURATIONS. Lindeman, A. J.; Leaf, G. K.; Kaper, H. G. Comput. Methods Appl. Mech. Eng.; 4: No. 1, 97-118(Jul 1974).

Detailed comparison studies are made of a high-order finite-element approximation and a low-order finite-difference approximation for the numerical solution of the static multigroup diffusion equations in two dimensions. Emphasis was placed on problems which have many material interfaces and corners, which are typical in reactor design and analysis studies. The finite-difference program used was a mesh-centered five-point difference approximation, while the finite-element program was based on the use of Lagrange interpolatory polynomial elements over a triangularization of the domain. It was concluded that for the class of problems studied a finite-element approach has a clear advantage over a finite-difference approach. (Appl. Mech. Rev.)

4878 HYDRODYNAMIC INSTABILITY IN PARALLEL CHANNELS WITH SODIUM TWO-PHASE FLOW. Peppler, W.; Schleisiek, K. Progr. Heat Mass Transfer; 441-449(1973).

The pressure drop of Na two-phase flow was measured with two test sections of 4 and 9 mm hydraulic dia. The results were compared with pressure-drop calculations using Chen's correlation for the liquid fraction as a function of the Lockhart-Martinelli parameter and Levy's model for the dependence of the two-phase pressure drop multiplier on the liquid fraction. The results agree rather well in the low-quality region. The measured and calculated two-phase pressure-drop results formed the basis for a description of the hydrodynamic instability behavior of parallel channels. (Metals Abstr.)

4879 CRITICAL-FLOW EXPERIMENTS IN A FORCED-CONVECTION BOILING-SODIUM LOOP. Costa, J.; Charlety, P. Progr. Heat Mass Transfer; 429-439(1973).

Consequences of critical flows occurring in a flashing facility and in a forced-convection-boiling loop are presented. A method is derived to determine if critical conditions are reached at the exit of a boiling test section in a forced-convection loop. The method has been tested on a boiling-Na loop and critical flow rates data are presented. (Metals Abstr.)

4880 SODIUM ENTRAINMENT IN AN ARGON FLOW: THE EVAPORATION AND CONDENSATION PROCESSES. Egleme, M.; Michel, A. Progr. Heat Mass Transfer; 503-516(1973).

The evaporation of liquid Na from cylindrical metal rods and nuclear fuel assemblies by heated Ar gas has been analyzed theoretically and tested by experiment. A residue of 10–15% of the initial amount of Na, mostly oxide of Na, is left on the rod using Ar and Na temp. ranging as high as 400°C. Further tests resulted in evaporation of 90% of the initial amount of Na in 15–20 min at 480°C Ar temp., for fuel rods wound with spacer wires. For single rods supported in spacer grids, only 40% of the initial amount of Na was evaporated in 20 min, and more complex geometries entrain even larger quantities of Na which cannot be removed by flowing dry Ar unless it is heated above 400°C. At these high temp., even using Ar with less than 20 ppm O, changes in the fuel cladding surface may occur. (Metals Abstr.)

4881 TEMPERATURE FIELDS IN LIQUID-METAL-COOLED ROD ASSEMBLIES. Nijsing, R.; Eifler, W. Progr. Heat Mass Transfer; 115-149(1973).

A survey is given of heat transfer in rod assemblies cooled by axial turbulent flow of liquid metal. The discussion is restricted to steady state conditions, uniform heat generation in the rods and fully developed flow and heat transfer. Theoretical considerations center on turbulent transport characteristics and on methodology of computation. An outline of recent work in this area is included. (Metals Abstr.)

4882 COMPARISON OF ANALYTIC AND LUMPED-PARAMETER SOLUTIONS FOR STEADY-STATE HEAT TRANSFER IN FUEL-ROD ASSEMBLIES. Ginsberg, T.; France, D. M. Progr. Heat Mass Transfer; 167-178(1973).

A comparative study of analytic and lumped-parameter methods applied to steady state heat transfer in nuclear fuel-rod assemblies is presented. The two methods were applied to an idealized, finite fuel-rod system which displays essential features of real fuel assemblies. Results show that excellent agreement between the two methods can be obtained if theoretically predicted length scales are used as "effective mixing lengths" for conduction heat transfer in the Cobra-II lumped-parameter computer code. If, however, adjacent cellular (sub-channel) centroid-to-centroid distances are used to approximate the effective mixing lengths, significant errors are generated in the temp. distributions predicted by lumped parameter methods. Evidence is presented which indicates that these errors in the lumped-parameter solution can be reduced by subdividing the fuel assembly into a larger number of cells. (Metals Abstr.)

4883 FLOW AND TEMPERATURE DISTRIBUTIONS AROUND LOCAL COOLANT BLOCKAGES IN SODIUM-COOLED FUEL SUBASSEMBLIES. Kirsch, D.; Schleisiek, K. Progr. Heat Mass Transfer; 239-249(1973).

The temp. distribution downstream of a blockage was measured with Na flowing in an annular channel, the inner part of which formed six subchannels. The outer wall was an induction-heated circular tube. A distinct recirculation was found in the wake behind the blockage. The mean residence time of the fluid in the recirculation zone was calculated from the temp. measurements. A comparison between the Na results and those obtained with water shows that heat conduction is negligible for the transport of heat between the flows inside and outside of the recirculation zone. Other experiments were performed in a water loop with a locally blocked rod bundle. The extent of the recirculation zone and the mass exchange between the flows inside and outside of this zone were measured. (Metals Abstr.)

4884 INFLUENCES OF HEATING METHODS AND ROD ECCENTRICITIES ON TEMPERATURE MEASUREMENT IN SODIUM EXPERIMENTS. Malang, S.; Rust, K.; Tschoke, H. Progr. Heat Mass Transfer; 207-217(1973).

The problem investigated concerns the accuracy with which the conditions in a Na-cooled fuel rod bundle can be simulated by electrically heated rods in heat transfer measurements. Up to 20% of error can be generated in the determination of the heat transfer coefficients as a result of different structures of the simulators. The error caused by the disturbance of the heat flux due to a thermocouple with MgO insulation installed in the cladding tube is of the same order of magnitude. Much more accurate results can be achieved with thermocouples in which a BN insulation is used instead of MgO. (Metals Abstr.)

Reactor Components and Accessories

Refer also to abstracts 2942 and 3499.

4885 (ORNL-5021) THEORETICAL AND EXPERIMENTAL STRESS ANALYSES OF ORNL THIN-SHELL CYLINDER-TO-CYLINDER MODEL 2. Gwaltney, R. C.; Bolt, S. E.; Bryson, J. W. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 181p. Dep. NTIS $7.60.

Model 2 in a series of four thin-shell cylinder-to-cylinder models was tested, and the experimentally determined elastic stress distributions were compared with theoretical predictions obtained from a thin-shell finite-element analysis. Both the cylinder and the nozzle of model 2 had outside diameters of 10 in., giving a d_0/D_0 ratio of 1.0, and both had outside diameter/thickness ratios of 100. Sixteen separate loading cases in which one end of the cylinder was rigidly held were analyzed. An internal pressure loading, three mutually perpendicular force components, and three mutually perpendicular moment components were individually applied at the free end of the cylinder and at the end of the nozzle. In addition to these 13 loadings, 3 additional loads were applied to the nozzle (in-plane bending moment, out-of-plane bending moment, and axial force) with the free end of the cylinder restrained. The experimental stress distributions for each of the 16 loadings were obtained using 152 three-gage strain rosettes located on the inner and outer surfaces. All the 16 loading cases were also analyzed theoretically using a finite-element shell analysis. The analysis used flat-plate elements and considered five degrees of freedom per node in the final assembled equations. The comparisons between theory and experiment show reasonably good general agreement, and it is felt that the analysis would be satisfactory for most engineering purposes. (auth)

4886 (RDT-F-3-6T(10-75)) NONDESTRUCTIVE EXAMINATION (SUPPLEMENT TO ASME BOILER AND PRESSURE VESSEL CODE, SECTION V). (Energy Research and Development Administration, Washington, D. C. (USA). Div. of Reactor Research and Development). Oct 1975. 15p. RSO.

1974 edition with addenda through Summer 1975.

Criteria are presented for radiographic examination, ultrasonic examination, liquid penetrant examination, magnetic particle examination, and leak testing. (JWR)

4887 INSURGE TRANSIENTS FROM A SURGE TANK USING CSMP. Cheng, S. C.; Kulkarni, K.; Birta, L. G. (Univ. of Ottawa). Simulation; 109-114(Oct 1974).

The Continuous System Modeling Program (CSMP) has become a widely used tool in simulation studies of engineering systems. This paper discusses one such application which involves the study of insurge transients from the surge tank of a nuclear reactor. The handling of the problem requires the simultaneous solution of the Fourier heat conduction equation together with an ordinary differential equation which describes the pressure variations in the surge tank. The results from this study are in good agreement with available experimental data. (auth)

4888 FLUID SHUT-DOWN SYSTEM FOR A NUCLEAR REACTOR. Barclay, F. W.; Frey, J. R.; Wilson, J. N.; Besant, R. W. (to Atomic Energy of Canada Ltd.). US Patent 3,900,365. 19 Aug 1975. Priority date 10 Oct 1972, Canada. 10p.

A nuclear reactor shut-down system is described which comprises a fluidic vortex valve for releasably maintaining a liquid neutron poison outside of the reactor core, the poison being contained by a reservoir and biased by pressure for flow into poison tubes within the reactor. The upper ends of the poison tubes communicate with the supply port of the vortex valve. A continuous gas flow into the control port maintains normal controlled operation. Shut-down is effected by interruption of the control input. One embodiment comprises three groups of poison tubes and one vortex valve associated with each group wherein shut-down is effected by poison release in two out of the three groups. Preferably, each vortex valve comprises three control ports which operate on a "voting" or two-out-of-three basis. (Official Gazette)

4889 NUCLEAR POWER PLANT TRAINING SIMULATOR SYSTEM AND METHOD. Ferguson, R. W.; Converse, R. E. Jr. (to Westinghouse Electric Corp.). US Patent 3,903,403. 2 Sep 1975. Filed date 23 Feb 1973. 30p.

A system is described for simulating the real-time dynamic operation of a full scope nuclear powered electrical generating plant for operator training utilizing apparatus that includes a control console with plant component control devices and indicating devices for monitoring plant operation. A general purpose digital computer calculates the dynamic simulation data for operating the indicating devices in accordance with the operation of the control devices. The functions for synchronization and calculation are arranged in a priority structure so as to insure an execution order that provides a maximum overlap of data exchange and simulation calculations. (Official Gazette)

4890 LONG-LIFE NEUTRON DETECTOR FOR INSTRUMENTATION OF A NUCLEAR REACTOR CORE. Klar, E. (to

Siemens Aktiengesellschaft). US Patent 3,903,420. 2 Sep 1975. Priority date 22 Nov 1971, F. R. Germany. 2p.

The invention concerns a neutron detector adapted for use in the core instrumentation of nuclear reactors. It comprises an emitter electrode which, upon irradiation with neutrons, emits electrons by means of (n, gamma) processes, a collector electrode, and a dielectric disposed between the emitter and the collector electrode. Thulium 169 or terbium 159 is used as the emitter substance. With this emitter substance a prompt signal is obtained, the magnitude of which hardly changes for years; any delayed signals that may build up and any interference currents due to them are so small that they can be compensated for by simple, known means. (Official Gazette)

4891 IMPROVEMENTS TO STEAM GENERATORS PARTICULARLY TO INTEGRATED GENERATORS FOR NUCLEAR PLANTS. Jabsen, F. S.; Schluderberg, D. C.; Paulson, A. E. (to Babcock and Wilcox Co., New York (USA)). French Patent 2,215,674/A/. 18 Jan 1974. 15p. (In French).

The improvements made to an energy production installation of the nuclear type are described. The separated coolant circuits are designed for a primary fluid and a secondary fluid. The installation contains a multiplicity of heat exchanger module groups. Each of these groups has a steam collector and a feed water collector separated from each other. They have two spaced tubular plates connected to the individual collectors in order to form a feed water inlet chamber and a steam evacuation chamber with the respective collectors. There is also a feed water tube passing across the steam evacuation chamber to create a fluid cummunication with the feed water inlet chamber and a multiplicity of tubes assuring fluid communication between the feed water inlet chamber and the steam evacuation chamber. (tr-FR)

4892 DEVICE FOR THE DETERMINATION OF THE VIBRATION COMPONENTS OF NUCLEAR REACTOR CORE. Carteus, M. F. M.; Gopal, Raj; Rawle, D. T. (to Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). French Patent 2,215,673/A/. 28 Jan 1974. 11p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 29 Jan 1973, USA.

An apparatus for the determination of the vibration of components of a reactor core is described. It consists of at least a first and a second detector sensitive to the neutron activity of the core in order to furnish electrical signals representative of this activity. These detectors are placed not far from the periphery of the core in positions diametrically opposed to it. They are accompanied by combined signal processing means in order to determine the vibration components of the core. This apparatus can be used in a nuclear reactor. (tr-FR)

4893 EDF EXPERIMENTAL TEST FACILITIES FOR MAIN COMPONENTS OF NUCLEAR POWER STATIONS. Blanc-Feraud, P. (Electricite de France, 78-Chatou. Service Machines et Automatismes de Production). pp 28-31 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975).

Several facilities essentially designed to test nuclear power plant equipment, whose purpose is to improve the availability of nuclear power stations, are described, including: test loop for water reactor primary pumps, test rig for separators, wet steam test turbine, and test loop for Super-Phenix pumps. (FR)

4894 LARGE STEAM TURBINES FOR NUCLEAR POWER STATIONS. Output Growth Prospects. Riollet, G. (Alsthom-Rateau, 93-La Courneuve (France)); Widmer, M. (Compagnie Electro-Mecanique (CEM), 75-Paris (France)); Tessier, J. (Electricite de France, 92-Courbevoie. Service Etudes et Projets Thermiques et Nucleaires). pp 31-32 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975).

The rapid growth of the output of nuclear reactors leads the manufacturer to evaluate technological limitations encountered. The problems dealing with the main components of turbines are reviewed, including: steam path, rotors and stators steam valves, control devices, shafts, and bearings. (FR)

4895 SPRING SPACER DEVICE FOR RESILIENTLY SUPPORTING NUCLEAR FUEL RODS. Tashima, J. (to Tokyo Shibaura Electric Co., Ltd.). US Patent 3,904,475. 9 Sep 1975. Priority date 19 Jan 1972, Japan. 4p.

Lantern type spring spacers which are mounted in a latticed frame by cross-pieces are respectively composed of square configured cylindrical end portions supported in the cross-pieces and four leaf spring members respectively provided between corresponding sides of the square cylindrical end portions. Each of the leaf springs includes flat end portions and a central outwardly bent portion which is projected against a nuclear fuel rod to be supported in the latticed frame. (Official Gazette)

4896 METHOD FOR OPERATING A STEAM TURBINE OF THE NUCLEAR TYPE WITH ELECTRONIC REHEAT CONTROL OF A CYCLE STEAM REHEATER. Luongo, M. C. (to Westinghouse Electric Corp.). US Patent 3,898,842. 12 Aug 1975. Filed date 29 Jan 1973. 22p.

An electronic system is provided for operating a nuclear electric power plant with electronic steam reheating control applied to the nuclear turbine system in response to low pressure turbine temperatures, and the control is adapted to operate in a plurality of different automatic control modes to control reheating steam flow and other steam conditions. Each of the modes of control permit turbine temperature variations within predetermined constraints and according to predetermined functions of time. (Official Gazette)

4897 METHOD AND APPARATUS FOR REVERSE CIRCULATING NUCLEAR STEAM GENERATOR SECONDARY FLUID. Stiteler, F. Z.; Honigmann, R. L. (to Combustion Engineering, Inc.). US Patent 3,900,010. 19 Aug 1975. Filed date 19 Apr 1974. 6p.

An apparatus is disclosed for inducing reverse circulation of the fluid on the secondary side of a steam generator of the type including an outer vessel and a vapor generation chamber having an annular baffle means dividing the chamber into an outer annular downcomer passage and an inner riser section. A quantity of gas is introduced into the lower end of the annular downcomer passage and allowed to bubble up the downcomer passage, thus creating a region of fluid density in the downcomer less than the fluid density in the inner riser section. The density differential there-between induces a natural circulation of the fluid down the riser section and up through the downcomer passage. (Official Gazette)

4898 LARGE DIAMETER REINFORCING BARS FOR THE CONSTRUCTION OF NUCLEAR POWER PLANTS. Tani, Yosio; Fujikawa, Y. (Kobe Steel, Ltd. (Japan)). FAPIG (Tokyo); No. 73, 19-27(Jun 1974). (In Japanese)

Large diameter reinforcing bars have been used for the construction of nuclear power plants since the plants must meet seismic standards. The amount of iron used for a nuclear power plant is not less than 10,000 tons, and too many reinforcing bars hamper workability. Development of large diameter reinforcing bars was considered accordingly, and type D-51 was produced. The shape of the newly developed bars is continuous node type, and the size is 50.8 mm diameter and 15.9 kg/mm^2 unit weight. A machine for bending the new bars was designed and manufactured. Good adhesive property of the new bars and concrete was demonstrated by pulling tests. Fatigue tests and fixing tests were carried out. Cracking tests by bending showed that the width of cracks was smaller than estimated. Methods for coupling the large diameter reinforcing bars are the lap joint method, gas heating-press connection, and the mechanical coupling method. (JA)

4899 RADIATION INSTRUMENTATION IN NUCLEAR POWER PLANT. Hasegawa, T. (Tokyo Shibaura Electric Co. Ltd., Fuchu (Japan). Fuchu Works); Kobayashi, A. Keiso; 18: No. 2, 22-27(Feb 1975). (In Japanese)

The purposes of radiation instrumentation in nuclear power plants are in the operation and control of reactor itself, release control of radioactive material, safety confirmation in working area and around the nuclear plants, and others. Radiation instruments are divided into the following five categories and described by referring to BWR nuclear power plants: neutron measuring instrument system for reactor operation and control; process radiation monitor to detect radiation levels in a plant; area radiation monitor for the continuous monitoring of spatial γ dose-rate in the plant and the confirmation of safety in working area conditions; fields radiation monitor aiming at the monitoring of spatial γ dose-rate in plant periphery and of atmospheric radioactivity concentration; and dosimeter for monitoring personal exposure. Outstanding features that distinguish these instruments from general radiation-measuring instruments are redundancy, isolating principle, fail-safe design, aseismic requirements and environment resistance, and complete quality control. (JA)

4900 APPARATUS FOR HANDLING NUCLEAR FUELS. Yukishima, I. (to Fuji Electric Co. Ltd., Tokyo (Japan)). Japanese Patent 1973-26716/B/. 29 Apr 1967. 3p. (In Japanese)

The present invention relates to a nuclear fuel processing

device, in particular, the fuel extracting mechanism thereof which is inserted into the channel located in the nuclear reactor core. The purpose of this invention is to provide a nuclear fuel processing device capable of simply and safely handling fuel without resorting to the conventional complicated mechanism, allowing the fuel extracting mechanism to be subjected to up and down motion. In the body of the fuel processing device, an operating rod is provided which will shift in the up and down direction relative to the device by means of its up and down motion. Furthermore, a pawl is provided so as to grasp a fuel grab head which opens and closes by interlocking with the up and down motion of said shifting. Finally, a rachet mechanism locking said operating bar is provided so as to actuate said operating rod and said nail rod by means of the up and down operation of said fuel processing device. Thus, the vertical motion merely allows the nuclear fuel processing device to actuate the fuel extracting mechanism, solving problems involved with remote control, especially during the utilization of high temperatures in the nuclear reactor core. (JA)

4901 STEELS AND WELDING OF EQUIPMENT OF NUCLEAR POWER STATIONS. Kontorovskii, A. Z. Therm. Eng. (USSR) (Engl. Transl.); 21: No. 10, 6-10(1974).

Translated from Teploenèrgetika; 21: No. 10, 5-9(1974).

Various types of steels used in reactor applications are listed, and the main techniques used in welding plate and pipe joints are illustrated. (DG)

Reactor Fuels

Refer also to abstracts 2588 and 2944.

4902 EQUIPMENT FOR THE LOADING OF NUCLEAR FUEL ELEMENTS IN A FUEL ROD. Rushworth, G. E. (to Exxon Nuclear Co., Richland, Wash. (USA)). French Patent 2,214,941/A/. 21 Jan 1974. 13p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 22 Jan 1973, US.

An apparatus is described for the charging of fuel elements in a fuel rod. It contains a glove box having methods of weighing and measuring the element charge and presenting, at its charging end, a target designed to receive the open end of a fuel rod. There is an element support spaced by a flange and provided with an elastic organ for element insertion filling the space separating the support from the flange. The apparatus can be used for charging fuel rods with fragile and hydroscopic fuel elements containing, for example, uranium oxide. (tr-FR)

4903 FUEL ELEMENT SHIPPING SHIM FOR NUCLEAR REACTOR. Gehri, A. (to Exxon Nuclear Co., Inc.). US Patent 3,900,116. 19 Aug 1975. Filed date 5 Sep 1972. 6p.

A shim is described for use in the transportation of nuclear reactor fuel assemblies. It comprises a member preferably made of low density polyethylene designed to have three-point contact with the fuel rods of a fuel assembly and being of sufficient flexibility to effectively function as a shock absorber. The shim is designed to self-lock in place when associated with the fuel rods. (Official Gazette)

4904 SOME PROBLEMS IN MANUFACTURING FACTORY OF NUCLEAR FUELS. Seki, Y. (Mitsubishi Nuclear Fuel Co., Tokai, Ibaraki (Japan). Tokai Works). Genshiryoku Kogyo; 20: No. 6, 35-39(Jun 1974). (In Japanese)

The features are described of the industry making uranium fuel for light water reactors. Conversion of UF_6 to UO_2 powder, forming of UO_2 pellets and construction of fuel rods are standard processes. However, handling must be carried out carefully. Uranium is under international control, is radioactive, has a critical limit quantity, and is expensive. UF_6 gas is poisonous and corrosive. Various considerations are necessary for fuel rods because the behavior of the fuel rods in operating reactors is not clearly known. Abnormal behavior reported includes local damage of cladding due to hydriding, compacting due to the heating of UO_2 pellets, collapse of claddings, and bending of fuel rods. Other problems are the control of dimensions of fuel rods, management of enrichment, inspection of damage or fault of claddings and pellets, management of uranium loss in the fabrication process, programs for recycle of uranium, and methods of reliable inspection. (JA)

4905 NUCLEAR FUEL ELEMENT. Maki, Hideo. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1974-19758/B/. 28 Dec 1968. 5p. (In Japanese).

In conventional nuclear fuel elements, a single space is provided within a sheath tube and a spring is disposed therein, thus intending to expand and move fuel pellets in the sheath tube along its length during reactor operation. Nevertheless, the fuel pellets do not always move freely on account of metallographic or density variations in the fuel pellet as well as cubic expansion attributable to the fission products. Therefore, the sheath tube is stressed by the fuel pellets and is sometimes damaged. Even in cases where the fuel pellets can expand and move, changes in the fuel distribution in the reactor core arise when the movement is made in only one direction. It is therefore feared that the nuclear properties will suffer. According to this invention, at least two spaces are provided within the sheath tube and the springs are disposed in these spaces, so that expansion and movement of the fuel pellets can take place in two directions. Herein, if all the spaces can absorb lengths exceeding the amounts of expansion of the fuel pellets, the lower fuel pellets will considerably descend due to their weight, nonuniformity of expansion, etc., and hence, the nuclear properties will suffer. In this respect, according to this invention, the springs are set so that the lower space may reach the limit of absorption earlier than the upper space. (JA)

4906 MULTIPLE TUBE TYPE SIMULATIVE FUEL BODY FOR THE GENERATION OF HEAT. Shimamune, H.; Toda, S.; Ishida, R.; Hatanaka, T. (to Japan Atomic Energy Research Inst., Tokyo). Japanese Patent 1974-23515/B/. 26 May 1969. 5p. (In Japanese).

In a conventional multiple tube type simulative fuel body which is used for testing a reactor and which includes therein resistors adapted to generate heat by the conduction of a current, it is difficult to mount elements for measurements and output temperature distributions in the radial and lengthwise directions of the fuel body cannot be set arbitrarily. A multiple tube type simulative fuel body according to this invention comprises electric resistors which are concentrically arranged into the form of a multilayer by interposing electric insulators between the adjacent layers. Since the respective resistors have power source terminals independently, at both ends, the temperature distribution in the radial direction can be easily simulated by adjusting electric power to be supplied to the terminals of the respective resistors. Further, when at least one layer of the resistors is partially cut away, nonuniform heat generation asymmetric with respect to the circumference of the fuel body can be simulated, while varying the cross-sectional area imparts a temperature distribution varied in the lengthwise direction. Still further, when the resistor at the central part of the simulative fuel body is replaced with a protective tube, lead wires for measurements can be passed through the interior thereof. (JA)

4907 METHOD FOR WIRE WRAPPING A NUCLEAR FUEL ROD. Iwamiya, T. (to Sumitomo Electric Industries Ltd., Osaka (Japan)). Japanese Patent 1974-32514/B/. 26 Dec 1969. 3p. (In Japanese)

A method of wire wrapping a fuel rod is described in which a fuel rod is inserted through a plurality of notched rotors arranged at prescribed pitch spacing intervals. A wrapping wire is fixed at one end to the fuel rod pin and, after being passed through the slotted portion of each rotor, is suspended under a tensioned condition along the fuel rod in the axial direction. One winding is accomplished between the first and second rotor by fixing the first rotor and simultaneously rotating the remaining rotors through one complete revolution. Successive windings are wound between each rotor pair in a similar manner, i.e., by fixing each succeeding rotor in the line and rotating those rotors remaining one complete revolution until the final winding is between the last two rotors. Accordingly, a prescribed winding pitch is set and uniformly applied by the rotors prearranged in a desired distribution, and the fuel rod is not subjected to bending stresses since the direction of tensile force of the wrapping wire is coincident with the lengthwise direction of the fuel rod. (JA)

4908 NUCLEAR FUEL ROD. Wakasugi, K. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1974-32911/B/. 11 Jun 1970. 4p. (In Japanese)

In a cladding tube charged with fuel pellets and sealed at both ends, a fuel rod is disclosed in which the so-called ridging or bambooing of the cladding tube is prevented by employing barrel-shaped fuel pellets with bulging sides. Pellets provided with a suitable degree of bulge will swell and deform during irradiation but will assume near cylindrical proportions as a result of their unique barrel shape. The cladding tube is therefore not unduly stressed which accordingly permits continuous operation even at high thermal output without fear of ridging and eventual rupture. (JA)

4909 NONLINEAR FINITE-ELEMENT METHOD FOR PLATES AND ITS APPLICATION TO DYNAMIC RESPONSE OF REACTOR FUEL SUBASSEMBLIES. Belytschko, T.; Mar-

chertas, A. H. J. Pressure Vessel Technol.; 96: No. 4, 251-257 (Nov 1974).

Employing a convected coordinate system and triangular flat plate elements, a nonlinear finite-element procedure for transient analyses of structures is described. The displacement functions used in this procedure are linear for membrane and cubic for transverse deformations. Discretized equations of motion are integrated explicitly in time with a difference formula so that the need for the formulation of element stiffness matrix is eliminated. The elastoplastic problems are solved with linear isotropic strain hardening, von Mises yield condition, and a flow law derived from Drucker's postulate. Solutions for several problems, including that for LMFBR reactor fuel subassemblies, have been obtained by the present procedure and compared with experimental results. Agreements appear to be quite satisfactory. (Appl. Mech. Rev.)

Reactor Control Systems

4910 (AGC-2212) DYNAMIC ANALYSIS AND ANALOG COMPUTER SIMULATION OF THE NERVA ENGINE. (Aerojet-General Corp., Azusa, Calif. (USA)). May 1962. 132p. Dep. NTIS $7.00.

Declassified 24 Sep 1975.

The NERVA power plant has been shown to be controllable from subpower nuclear operation, through engine startup, at design thrust conditions, and during shut-down. A nonlinear analog simulation of the overall engine was developed and used. A representative control system with expected nonlinearities has been analyzed, including the interaction between control loops, and transfer function block diagrams have been prepared. (auth)

4911 TIHANGE NUCLEAR PLANT. Power Distribution Control. Gouffon, A.; Lecocq, J. M. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92-Courbevoie (France)). pp 70-71 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975). (American Nuclear Society, Hinsdale, Ill.).

Among other Westinghouse three-loop plants, the Tihange plant has the highest linear power density. Severe control systems have thus been developed. The reactivity control system, power distribution control, and axial power distribution monitoring system are described. (FR)

4912 CONTROL METHOD AND APPARATUS OF LIQUID METAL COOLED FAST NEUTRON REACTOR. Watanabe, T.; Ueno, K. (to Mitsubishi Atomic Power Industries, Inc., Tokyo (Japan)). Japanese Patent 1974-8678/B/. 4 Dec 1968. 2p. (In Japanese)

A gas space is provided at the position where the void coefficient of the core liquid metal is positive. Suspension of reactor operation and the control of the output can be accomplished by removing wholly or partially the gas section. An apertured tube is inserted into the core. Gas pressure is applied to the apertured tube and adjusted so that the liquid metal level in the apertured tube may be adjusted by regulating the gas pressure, thus controlling the reactor. When the reactor is operated in the normal state, the liquid metal in the tube is thrust down by the gas pressure applied via the inactive gas supplying device. When it is desired to suspend inert reactor operation, a valve is opened and the surface of the liquid metal in the tube rises to the position corresponding to that in the reactor. The valve operation causes the inert inactive gas space in the tube to be reduced. If the core is designed to obtain a positive liquid metal void coefficient at the periphery of the core section tube, the core operation will cease. The section near the center of the core is known to have a positive liquid metal void coefficient. Without limiting the utilization of gas pressure, the method of removing the gas section at the desired time by providing the said section in the core while normally operating allows reactor operation to cease. (JA)

4913 APPARATUS FOR AUTOMATICALLY PACKING A NEUTRON ABSORBER. Watanabe, M. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1974-18679/B/. 20 Nov 1968. 5p. (In Japanese)

A control rod for a boiling water type reactor is made by packing a powdered neutron absorber, such as boron carbide, into a cladding tube and inserting steel balls thereinto. Packing of the boron carbide, the insertion of the steel balls and confirmation of steel ball position have hitherto been executed by hand. This invention provides an apparatus which automatically performs the above tasks. Since a 500 MW-class BWR power plant requires about 8,000 control rods, automation according to this invention is very advantageous. (JA)

Nuclear Power Plant Economics

4914 CAPITAL NEEDS AND FINANCIAL REQUIREMENTS FOR PROGRAMS OF NUCLEAR PLANT CONSTRUCTION IN VARIOUS COUNTRIES. Williams, I. G. K.; Haussermann, W. (Nuclear Energy Agency, 75-Paris (France)). pp 293-294 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975).

The capital requirements in a number of industrialized countries are assessed and the main regions of the OECD area are compared. (FR)

4915 THE STAKE OF THE FRENCH ELECTRO-NUCLEAR PROGRAMME. Boiteux, M. (Electricite de France, 75-Paris). Rev. Gen. Nucl.; 1: No. 1, 1-4(Feb 1975). (In French).

At the end of the century, neither classic resources nor so-called "new" energies will be able to satisfy France's needs. The consequences for France of developing nuclear energy are examined. Nuclear energy could strengthen its energy independence, save foreign currencies, and lower its financial load, for the "nuclear" KWh is about twice cheaper than the "classic" one. It is considered that the real choice to which France is confronted is either to resort to nuclear energy or to endanger seriously its economic and social development. (FR)

4916 POWER MODULATION FOR NUCLEAR POWER STATIONS SUPPLYING ELECTRIC POWER OR HEAT DISTRIBUTION NETWORKS. Pacault, P.; Tillequin, J. (Fives-Cail-Babcock, 75-Paris (France)). pp 273-275 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975).

The advantages of the thermal energy storage are presented. The heat is stored in a liquid having a high-boiling point. It is possible to use low-cost materials having an excellent stability during the temperature cycles. The application of the process to the power modulation of generating plants has been studied. Linking up heat accumulators to a nuclear power station makes it possible for the latter to supply variable amounts of electric and thermal power while keeping the reactor at constant power. (FR)

4917 HOW TO SATISFY MANPOWER REQUIREMENTS: THE VIEWPOINT OF INDUSTRY. Ladonchamps, J. De (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92-Courbevoie (France)). pp 292-293 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975).

The manufacturers must take emergency actions with respect to training to cope with fast growing programs for nuclear power plant construction. They receive some help from academic and research institutions, but they must rely on their own resources for most of the training. On the other hand, the manufacturers cannot help but rely on universities to provide basic education for the personnel. A continued exchange of views between the manufacturers and the universities is needed in order to be prepared to solve long-range problems. (FR)

4918 SURVEY OF THE ATOMIC ENERGY INDUSTRIES IN JAPAN FOR FISCAL 1973. Genshiryoku Chosa Jiho; No. 27, 1-66(May 1975). (In Japanese)

A survey of atomic energy enterprises in Japan covers the period of April 1973 to March 1974, including: proceeds, expenditures, and personnel in the firms of mining and manufacturing, electric power, and trading. The number of firms subject to the survey was 1,197, and 73.8% answered the questionnaire. With the advance of nuclear power generation in the country, including the domestic development of power reactors, the expenditures and proceeds in mining and manufacturing are on the increase, in which the costs of production are mounting due

to inflation. While expenditures for research and development continue to rise, the facilities investments are decreasing due to the uncertain future power demands. (JA)

Reactor Fuel Cycle Economics

4919 FINANCING OF THE NUCLEAR FUEL CYCLE. Wyart, P. (Organization des Producteurs d'Energie Nucleaire (O.P.E.N.), 75-Paris (France)). pp 294-295 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975).

Fuels account for only one-fourth of the cost of nuclear energy. The capital financing charges exceed one-half. But it is necessary to take account of the combined effect of the magnitude of the needs in coming years and of the resulting acceleration due to the coming on stream of nuclear power plants. It is also necessary to take account of the characteristics of the fuel cycle, which is especially long because of technical requirements and the necessity to establish safety stocks. (FR)

4920 PRESENT STATUS ON PLUTONIUM RECYCLE OF LIGHT WATER REACTOR. Takanishi, N. (Kansai Electric Power Co. Inc., Osaka (Japan)). Genshiryoku Kogyo; 20: No. 11, 41-44(Nov 1974). (In Japanese)

Two main merits obtained by plutonium recycle are the economy of uranium resources and the reduction of necessary enrichment factor. The plutonium recycle will economize uranium ore by 10 to 30 percent. The present capacity of fuel enrichment facilities in the United States of America, for example, can only afford the enriched fuel assigned for nuclear power plants of 290 GW(e), but the employment of the plutonium recycle will expand the enrichment capacity up to 350 GW(e). The economy of fuel cost by the plutonium recycle is reported to be 10 to 15 percent. If plutonium is not recycled, the plutonium must be stored for a long time, and the storage cost will push up fuel cost. In the United States of America, various irradiation tests are underway, and plutonium recycle is under development. In Netherlands, four irradiation cycles have been performed in the Dodewaard plant. In Kahl plant in West Germany, the planning of a plutonium burning reactor has been finished. In the Garigliano reactor in Italy, the demonstration program is almost over, and a full scale plutonium recycle program is scheduled. The most important problems regarding the plutonium recycle are the irradiation characteristics and the in-core performance of plutonium fuel. A recent USAEC paper reported that enough experience to assure the utilization of plutonium fuel to commercial light water reactors has been obtained by experiments and demonstration tests, and that it is possible to substitute uranium fuel with mixed oxide fuel ($PuO_2 + UO_2$), for the in-core performance of the mixed oxide fuel differs little from that of uranium dioxide fuel and for accident analysis does not make any clear difference between a mixed oxide fuel core and a uranium fuel core. (JA)

Reactor Licensing and Regulation

4921 (DOCKET-50261-546) H. B. ROBINSON PLANT, UNIT 2. Semiannual Operating Report No. 10, January-June 1975. (Carolina Power and Light Co., Raleigh, N. C. (USA)). 1975. 324p. Dep. NTIS $19.25.

Net electrical power generated was 2,051,619 MWH(e) with the reactor on line 3,063.39 hrs. Information is presented concerning power generation, shutdowns, corrective maintenance, chemistry and radiochemistry, occupational radiation exposure, release of radioactive materials, and abnormal occurrences. (FS)

4922 (DOCKET-50266-314) POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2. Semiannual Operating Report No. 10, January-June 1975. (Wisconsin Electric Power Co., Milwaukee (USA)). 25 Aug 1975. 119p. (DOCKET-50301-286). Dep. NTIS $9.00.

Unit 1 operated at an average capacity factor of 65.2 percent with a net efficiency of 31.41 percent. Unit 2 operated at an average capacity factor of 88.6 percent with a net efficiency of 32.28 percent. Unit 1 was essentially base loaded while Unit 2 operated on load follow. Information is presented concerning power generation, shutdowns, corrective maintenance, chemistry and radiochemistry, occupational radiation exposure, release of radioactive materials, abnormal occurrences, and environmental monitoring. (FS)

4923 (DOCKET-50280-443) SURRY POWER STATION, UNITS 1 AND 2. Semiannual Operating Report, January-June 1975. (Virginia Electric and Power Co., Richmond (USA)). 29 Aug 1975. 579p. (DOCKET-50281-381). Dep. NTIS $32.00.

Net electric power generated by Unit 1 was 2,315,124 MWH(e) and Unit 2 generated 2,062,954 MWH(e) with Unit 1 generator on line for 3,157.8 hrs and Unit 2 on line for 2,881.2 hrs. Information is presented concerning power generation, shutdowns, corrective maintenance, chemistry and radiochemistry, occupational radiation exposure, release of radioactive materials, abnormal occurrences, and environmental monitoring. (FS)

4924 (DOCKET-50285-384) FORT CALHOUN STATION, UNIT 1. Semiannual Operating Report, January-June 1975. (Omaha Public Power District, Nebr. (USA)). 28 Aug 1975. 115p. Dep. NTIS $8.75.

Net electrical power generated was 604,751.4 MWH(e) with the reactor on line 2,049.9 hrs. Information is presented concerning power generation, shutdowns, corrective maintenance, chemistry and radiochemistry, occupational radiation exposure, release of radioactive materials, abnormal occurrences, and environmental monitoring. (FS)

4925 (DOCKET-50305-326) KEWAUNEE NUCLEAR POWER PLANT, UNIT 1. Semiannual Operating Report, January-June 1975. (Wisconsin Public Service Corp., Green Bay (USA)). 21 Aug 1975. 223p. Dep. NTIS $14.25.

Net electrical power generated was 1,634,959 MWH(e) with the reactor on line 3929.46 hrs. Information is presented concerning power generation, shutdowns, corrective maintenance, chemistry and radiochemistry, occupational radiation exposure, release of radioactive materials, abnormal occurrences, and environmental technical specifications. (FS)

4926 (LPL-TR-017.1) QUALITY ASSURANCE PROGRAM. (Louisiana Power and Light Co., New Orleans (USA)). 12 Aug 1975. vp. Louisiana Power and Light Co., New Orleans, LA.

A detailed description of the Louisiana Power and Light Company quality assurance program, to be used during the design and construction of nuclear power plants, is presented. (JWR)

4927 (NP-20703) PARSONS QUALITY ASSURANCE PROGRAM FOR NUCLEAR FACILITIES. Topical Report P-TOP-QA1. (Parsons (Ralph M.) Co., Pasadena, Calif. (USA)). 1 Oct 1975. vp. Ralph M. Parsons Co., Pasadena, CA.

This report describes Parsons Quality Assurance Program plan for use by those organizations within Parsons that have responsibility for nuclear-safety-related systems, structures, or components and the services related to them during the design, procurement, and construction phases of the nuclear facility project. This program meets the requirements of Nuclear Regulatory Commission Regulation 10 CFR Part 50, Appendix B. (auth)

4928 (NUREG/PRDI-75/10) POWER REACTOR DOCKET INFORMATION. (Energy Research and Development Administration, Oak Ridge, Tenn. (USA). Technical Information Center). Oct 1975. 73p. TIC.

Citations and subject indexing to the documentation associated with civilian nuclear power plants are presented. This material is that which is submitted to the U.S. Nuclear Regulatory Commission in support of applications for construction and operating licenses. Citations are listed by Docket number in accession number sequence. The Table of Contents is arranged both by Docket number and by nuclear power plant name. (DCC)

4929 (NUREG/PRDI-75/11) POWER REACTOR DOCKET INFORMATION. (Nuclear Regulatory Commission, Washington, D.C. (USA)). Nov 1975. 98p. TIC $1.85.

Citations and subject indexing to the documentation associated with civilian nuclear power plants are presented. This material is that which is submitted to the U. S. Nuclear Regulatory Commission in support of applications for construction and operating licenses. Citations are listed by Docket number in accession number sequence. The Table of Contents is arranged both by Docket number and by nuclear power plant name. (DCC)

4930 (ORNL-tr-4041) GUIDELINE FOR CERTIFICATION OF TECHNICAL KNOWLEDGE OF NUCLEAR POWER PLANT PERSONNEL. 8 Oct 1974. Translation by R. G. Mansfield of UA II 4-513 805/2. 8p. Dep. NTIS $4.50.

Detailed procedures are described by which managers and operators of nuclear power plants must be certified according to German law. (LTN)

4931 (RDT-STATUS-(10-75)) BIMONTHLY STATUS REPORT OF RDT STANDARDS. (Energy Research and Development Administration, Washington, D. C. (USA). Div. of Reactor Research and Development). Oct 1975. 42p. RSO.

4932 (REG/G-1.79(Rev.1)(9-75)) PREOPERATIONAL TESTING OF EMERGENCY CORE COOLING SYSTEMS FOR PRESSURIZED WATER REACTORS. (Nuclear Regulatory Commission, Washington, D. C. (USA). Office of Standards Development). Sep 1975. 4p. NUREG.

This guide describes a preoperational test program acceptable to the staff specifically for emergency core cooling systems (ECCS) in pressurized water reactor power plants. Although this guide is applicable to all pressurized water reactors, certain aspects may not be completely applicable to specific nuclear steam supply designs. (auth)

4933 PRACTICE AND EVOLUTION OF LICENSING PROCEDURES AND OF NUCLEAR REGULATION IN FRANCE. Servant, J. (Ministere de l'Industrie et de la Recherche, 75-Paris (France). Service Central de Surete des Installations Nucleaires). pp 290-291 of Nuclear Energy Maturity. Communications of the I. European Nuclear Conference. Paris, 21-25 April 1975. Lehoulier, J.; Mantega, M. (eds.). Clamart, France; Societe Francaise de l'Energie Nucleaire (1975). (In French).

From 1st European nuclear conference; Paris, France (21 Apr 1975).

In the last two years, important work has been done concerning licensing procedures and regulation particular to nuclear installations. The first important reform was the creation, by decree of March 13, 1973, of the Conseil Superieur de la Surete Nucleaire (CSSN) attached to the Ministry of Industry and Research and the Service Central de surete des Installations nucleaires (SCSIN). A second reform, implemented by a decree (March 27, 1973), defined the procedure for licensing and surveillance of nuclear installations. The Ministry of Industry and Research is in charge of developing so called general technical regulations, i.e., to be applied to all nuclear installations of a given category. (FR)

GENERAL AND MISCELLANEOUS

Information Handling

4934 (CONF-750967-10) INFORMATION SUPPORT OF ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION'S ENVIRONMENTAL PROGRAM AT OAK RIDGE NATIONAL LABORATORY. Ulrikson, G. U. (Oak Ridge National Lab., Tenn. (USA)). 1975. Contract W-7405-eng-26. 48p. Dep. NTIS $5.50.

From 3rd ERDA environmental protection conference; Chicago, Illinois, USA (23 Sep 1975).

The primary function of the Information Center Complex (ICC) at Oak Ridge National Laboratory, Oak Ridge, Tennessee, is to develop and correlate the information activities of the energy and related environmental research projects at ORNL and to systematize operations to achieve maximum response to the information needs of funding agencies and user community. The development of new data bases and information services as need arises is a major responsibility of ICC. Interactions among segments of ICC provide for a wide range of analysis and synthesis of knowledge, resulting in a synergistic effect. Present methods used to retrieve environmental information from the scientific literature are reviewed with respect to specific procedures employed by ICC, and the use of highly specialized data bases in relation to manual and computerized sources is discussed. Procedures employed for different types of queries and the search strategy utilized are summarized indicating the extent of coverage from the various data bases. The ICC matrix organization is described. This organizational structure is representative of the subject area disciplines which contribute to biomedical and environmental information and an intersecting structure which provides for the accomplishment of mission-oriented tasks overlapping general disciplines. The advantages of a matrix organization are discussed. (auth)

Management

Refer also to abstract 2716.

4935 (NP-20713) NEA THIRD ACTIVITY REPORT, 1974. (Nuclear Energy Agency, 75-Paris (France)). 1975. 67p. Dep. NTIS (US Sales Only) $6.00.

The report opens with a summary of activities for 1974. The body of the report is arranged as follows: nuclear power, present and future (current trends, longer-term aspects); regulatory aspects (background, safety of nuclear installations, waste management, radiation protection, nuclear low); technical development (joint undertakings, gas-cooled fast reactors, direct conversion, isotopic batteries); and nuclear energy information (background, specialist committees and services, neutron data compilation center, computer program library). (1 figure, 4 tables) (RWR)

4936 (TID/SNA-3088) ANNULAR-FLOW NOZZLES FOR SOLID-PROPELLANT ROCKETS. Annual Report for the Period December 1961–November 1962. Williams, J. J.; Hurr, G. B. (Aerojet-General Corp., Sacramento, Calif. (USA)). 2 Jan 1963. 143p. Dep. NTIS $7.00.

Declassified 24 Sep 1975.

Subscale models of plug nozzles, inverse-plug nozzles, and shrouded plug nozzles have been tested extensively in cold-flow studies and in motor firings with both single and two-phase (condensed and gas phases) exhaust products. The program was restricted to performance studies and included only those design studies necessary for successfully designing test-weight models. Performance data are discussed, and results of investigations conducted during Fiscal Years 1961 and 1962 are summarized. The adequacy of numerical design technique and performance prediction, and the applicability of annular-flow nozzles to solid-propellant rockets, are discussed. (auth)

4937 (TID/SNA-3105) STATUS OF GAS-PARTICLE FLOW STUDIES AT AEROJET. Lorenc, S. A. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jun 1964. 29p. Dep. NTIS $4.50.

Declassified 24 Sep 1975.

The gas-particle flow studies conducted over the past several years are reviewed. After brief discussion of the one and two-dimensional simplified techniques, an axisymmetric coupled solution is described in some detail. Then the correlation of the analytical with experimental results are discussed and performance predictions are made of several new nozzle designs. It is concluded that a computer program in its present form can be used to predict performance of moderately contoured nozzles with a sufficient degree of accuracy for practical design purposes. To extend its applicability to a wider range of particle concentrations and nozzle configurations, a refinement of transonic solution is recommended. Finally, the need for more accurate particle properties is emphasized. (auth)

4938 OM ATOMKRAFTENS TEKNISKE OG SAMFUNDSMAESSIGE PROBLEMER. Projektunderstoettende Kursus. (Technical and Social Problems of Atomic Power–Course Material). Winther, A. C. Aalborg, Denmark; Centerforlaget, Aalborg Universitetscenter (1974). 46p.

Material is presented for a university course dealing with nuclear energy including the following subjects: nuclear physics, listing of nuclear energy, nuclear weapons, strategical balance of power, proliferation of nuclear weapons, civil use of nuclear energy, fuel cycle, nuclear programs in different countries, principles of nuclear reactors. (DA)

4939 EPA'S ENVIRONMENTAL RADIATION-ASSESSMENT PROGRAM. Rowe, W. D. (Environmental Protection Agency, Washington, DC); Galpin, F. L.; Peterson, H. T. Jr. Nucl. Saf.; 16: No. 6, 667-682(1975).

A principal role of the Environmental Protection Agency's Office of Radiation Programs is to assess environmental radioactivity levels and to estimate the impact of radiation technology on man and his environment. This article describes the approach of the EPA and its program to fulfill this role. (auth)

Mathematics and Computers

Refer also to abstract 2934.

4940 (CONF-750482-1) BASIC INTERRUPT AND COMMAND STRUCTURES AND APPLICATIONS. Davies, R. C. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). 1974. 5p. Dep. NTIS $4.00.

From DECUS symposium; Miami, Florida, USA (15 Apr 1975).

Interrupt and command structures of a real-time system are described through specific examples. References to applications of a real-time system and programing development references are supplied. (auth)

4941 (CONF-750482-3) MULTIPLE-TASK REAL-TIME PDP-15 OPERATING SYSTEM FOR DATA ACQUISITION AND ANALYSIS. Myers, W. R. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). 1974. 4p. Dep. NTIS $4.00.

From DECUS symposium; Miami, Florida, USA (15 Apr 1975).

The RAMOS operating system is capable of handling up to 72 simultaneous tasks in an interrupt-driven environment. The minimum viable hardware configuration includes a Digital Equipment Corporation PDP-15 computer with 16384 words of memory, extended arithmetic element, automatic priority interrupt, a 256K-word RS09 DECdisk, two DECtape transports, and an alphanumeric keyboard/typer. The monitor executes major tasks by loading disk-resident modules to memory for execution; modules are written in a format that allows page-relocation by the monitor, and can be loaded into any available page. All requests for monitor service by tasks, including input/output, floating point arithmetic, request for additional memory, task initiation, etc., are implemented by privileged monitor calls (CAL). All IO device handlers are capable of queuing requests for service, allowing several tasks "simultaneous" use of all resources. All alphanumeric IO (including the PC05) is completely buffered and handled by a single multiplexing routine. The floating point arithmetic software is re-entrant to all operating modules and includes matrix arithmetic functions. One of the system tasks can be a "batch" job, controlled by simulating an alphanumeric command terminal through cooperative functions of the disk handler and alphanumeric device software. An alphanumeric control sequence may be executed, automatically accessing disk-resident tasks in any prescribed order; a library of control sequences is maintained on bulk storage for access by the monitor. (auth)

Miscellaneous

4942 DIVERSIFIED PROJECT PROGRAMS OF NATIONAL NUCLEAR INSTITUTES DRAWN UP FOR FY 1974. At. Jpn.; 18: No. 5, 16-19(May 1974).

The major national institutes in Japan related to nuclear de-

velopment released, respectively, the project programs for 1974. Japan Atomic Energy Research Institute (JAERI) has been granted a budget of about Y19.4 billion plus about Y5.1 billion on the pledge of disbursement after fiscal 1975. Power Reactor and Nuclear Fuel Development Corporation (PNC) has budgeted approximately Y58 billion for payments. Five items including HTGR, ECCS, nuclear fusion, and reactor safety in JAERI, and FBR, ATR, uranium enrighment, and fuel reprocessing plant in PNC are described as their main programs. National Institute of Radiological Sciences (NIRS) is reorganizing its structure to strengthen capacity by establishing a new Nakaminato Branch, Environmental Radioactive Contamination Research Division, and Ocean Radioactivity Research Division being ready by July 1974. The reorganization of NIRS includes the addition of "Research into medical utilization of neutron beams" which will make the three special research projects complete. (JA)

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This handbook provides a selective treatment of those physical and kinetic properties of aerosol systems which are fundamental to the solution of many particulate problems confronting both nuclear and nonnuclear industries. Although the handbook was prepared with the interests of the nuclear industry in mind, the coverage is sufficiently broad to provide support to many diverse groups and activities. It is directed to two major audiences, scientists and engineers directly responsible for research and development programs and administrative personnel whose responsibilities require a practical understanding of aerosol systems.

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